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1. MANAGEMENT

Competition

Don't Fall Into the "Convenience and Necessity" Trap. A. F. Dyer. *Butane-Propane News 23,* 68 (1961) Oct. (3 pp.)

Too many LP gas dealers are ready to abandon the philosophy of free enterprise and the theory that competition is healthy. Too many of them will readily agree to, or even be a party to restricting competition.

Gas and Dual Fuel Engines. *Lubrication 47,* 93 (1961) Sept. (16 pp.)

Since the war, the production and utilization of engines capable of burning gas or a combination of gas and liquid fuel have increased at a phenomenal rate. This is the result of the tremendous expansion of natural gas transmission to many parts of the country. Generally speaking, gas and gas-diesel or dual-fuel engines are easier to lubricate than comparable engines which are operated continuously as full diesels.

Gas Futures — Unlimited. W. G. Hamilton, Jr. *Appliance Manufacturer 9,* 47 (1961) Oct.

This will be a record-breaking decade for the gas and gas equipment industries. Gas not only is firmly established as the nation's No. 1 house-heating fuel, but, as installations of gas furnaces, boilers, conversion burners, direct and other types of gas heating equipment continue to rise, other uses of gas in the home continue to multiply. More people than ever are finding it practical and economical to use the same fuel for cooking, water heating, clothes drying, refrigeration, refuse disposal, and air conditioning, as well as heating.

Gas Lights Way for Safe Landings. *A.G.A. Monthly 43,* 13 (1961) Oct. 2 pp.)

The first two gas-lit airports in the United States began operation in Arkansas, and the third—fully automatic—went bright July 11, 1961, in Syracuse, Kansas, through the efforts of the Plateau Natural Gas Co.

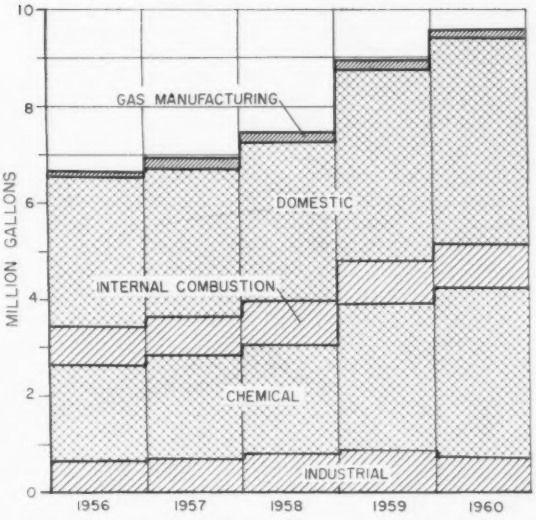
Is Electric Heat Economical? G. M. Fraser. *Fueloil & Oil Heat 20,* 70 (1961) Sept. (3 pp.)

This report covers the findings in a study comparing the cost of heating with oil and electricity. The study extended over four heating seasons, considered factors that normally might be ignored, was based upon accurate records and was undertaken without bias or prejudice. It should be of much interest to fuel oil and oil heating dealers, since the study took place in a "cold" area, where electric heat might not be considered feasible.

LPG-Ethane Sales Rose 7% in 1960, Says Bureau of Mines. *Butane-Propane News 23,* 64 (1961) Oct. (1 pp.) *LP Gas 21,* 33 (1961) Nov. (2 pp.) *Gas Age 128,* 30 (1961) Oct. 12 (2 pp.)

Domestic sales of LPG and ethane (excluding their use in gasoline) increased 7% in 1960, according to the annual Bureau of Mines report issued at the end of August. This represented a substantial leveling off from the 20% gain shown in 1959. Total gallonage reached 9,544,699,000. In addition, 1,899,660,000 gals. was shipped for use in gasoline, some 18% more than in 1959, while exports were 125,496,000, more than 33% above 1959. In the latter case the total was considerably short of 1957's high of 190,603,000.

Sales of LP Gas plus Ethane Excluding Gasoline



Based on *Butane-Propane News* See abstract p. 253.

Cost Accounting

Operating Cost Depends on Process. W. L. Nelson. *Oil Gas J. 59,* 97 (1961) Nov. 6.

Enough data have been accumulated and adequate methods of correlation have been developed for the presentation of refinery operating costs in terms of the processes conducted. Direct and total operating costs for the many processes conducted in an average United States refinery are shown.

Federal Power Commission

Biggest Gas Deal in Industry's History Goes Before FPC. *Oil Gas J. 59,* 66 (1961) Oct. 16. (2 pp.)

The FPC was asked to approve portions of a billion-dollar transaction that will guarantee to eastern markets —with no escalation in rates—6.2 trillion CF of gas over the next 30 years. Most of the gas would come from four King Ranch fields of Humble Oil & Refining Co. Monterey Gas Transmission Co., a new transporter, filed the key application for authority to move the King Ranch gas in South Texas into the Columbia lines at Alexandria, Louisiana. It will buy Humble's 238 mile, 30 in. line from the King Ranch gas plant to Clear Lake near Houston and 91.8 miles of 8-to-24 in. laterals which gather the gas from 86 reservoirs. Monterey will build a 216-mile, 30 in. main transmission line.

Gas Producers Question Legality of Low Field Prices. H. Ralph. *Oil Gas J. 59,* 78 (1961) Nov. 6 (2 pp.)

Gas producers have taken a new approach to the prob-

lem of federal regulation of natural-gas field prices. They propose incentive gas pricing. FPC acceptance of the producers' thesis could break the logjam at the agency and end the confusion which has existed since the Supreme Court's 1954 decision in the Phillips' case.

Foreign Activities

Britain Ready to OK LNG Imports. *Oil Gas J. 59,* 87 (1961) Nov. 6.

Cabinet is expected to announce that it has approved the first big-scale importation of liquid gas from North Africa. The project has been held up because of the coal industry's opposition, but apparently the government is now sold on the plan. The government plan expected to be approved is: a $29.4-million investment, all of it in England for the equipment and installations necessary to handle the liquefied gas once it reaches Canvey Island. About $8.4 million would be for shore installation and storage, including five 2,000-ton refrigerated tanks. The remaining $21 million would go into a reformer unit to convert the liquefied methane into the lower calorific town gas. Two tankers of about 26,000 tons, each capable of carrying 11,000 tons of the liquefied gas (about 575,000 MCF) will be built and chartered by British Methane, Ltd. a joint venture of Conch International and the British Gas Council.

Japan's Rigs Push Search For Petroleum Reserves. *Drilling 22,* 107 (1961) Sept. (2 pp.)

Exploration for and exploitation of petroleum resources in Japan have been carried on almost exclusively by a semi-governmental corporation, the Japan Petroleum Exploration Company (JAPEX) and two domestic oil companies, Teikoku Oil Company and Nippon Mining Company. There are several independent operators which engage in the drilling of gas wells, but their activities are negligible. During 1960, a total of 197 oil wells and 190 gas wells were drilled.

Short Survey of the Swedish Gas Industry in 1960. C. Lindgren. *J. Ind. du Gaz 85,* 371 (1961) Aug.-Sept. (2 pp. French text.)

As in other European countries, the Swedish gas industry was developed in the middle of the 19th century. The first plants for producing gas from coal were begun near Goteberg in 1846, then some similar plants were built in the south and central part of Sweden. In the second half of the 19th century, use of gas for blast furnaces and metallurgical coke ovens was begun. The latest contribution from the gas industry—fabrication of petrochemicals—such as propane and butane did not begin until after the second world war. There is no natural gas, and consequently the great distance between its origin and the consumers has not permitted the building of pipelines to transport gas any great distance. As to the concern over fossil fuels, the country possesses only that from wood and from peat. As a consequence, both coal and petroleum must be imported.

Three Finds Awaken Bolivia. J. C. McCaslin. *Oil Gas J. 59,* 152 (1961) Oct. 16 (3 pp.)

Three recent discoveries at Caranda, Algarrobillo, and Rio Grande have brightened the rather dim oil picture in Bolivia. This summer Gulf brought in its fourth well at Caranda. Recovery was 60 bbl of 53°-gravity crude on a 90 minute test from perforations at 3,573 ft. In September this year Gulf announced discovery of gas condensate at its 1 Rio Grande wildcat, 35 miles southeast of Santa Cruz. The discovery flowed 9 MMCFD through ½ in. opening from 5,200 ft pay. Some condensate accompanied the gas.

USSR Keys Industrial Growth to Gas. E. Adams. *Petrol. Eng. 33,* 174 (1961) Oct. (4 pp.)

The Soviet gas industry is definitely in its infancy having produced only 1.66 trillion CF in 1960 and with planned production for 1965, the last year of the current seven-year plan, of only 5.3 trillion CF. The United States, by comparison, was producing at the rate of 5 trillion per year at the end of 1946 from a proved reserve of over 160 trillion. The Russian's proved gas reserves are now only about 70 trillion CF and their goal for the end of 1965 is 107 trillion. The Soviet gas industry is booming, but this year is behind the 7 year plan. Technically, the Soviet follows the USA methods but personnel-wise it uses many more people, including women, and has complete disregard for safety. Differences between United States and Soviet industry are wide in volume and this will probably be true far into the future.

Petroleum Production

Caution Marks Forecast of Oil Growth. *Oil Gas J. 59,* 78 (1961) Oct. 16.

In its annual study of the oil business published last week, Chase Manhattan Bank says oil and gas will furnish 66% of the energy used by the free world in 1970. Total free world energy consumption will increase 50% in the next ten years. Oil use will increase 73% in the next decade, but natural-gas growth will double.

Promotion

'Advance Home' is Glimpse of Future. *A.G.A. Monthly 43,* 2 (1961) Oct. (3 pp.)

In Dallas this month, more than 2,000 A.G.A. Convention-goers, and more than 2 million expected visitors to the Texas State Fair, were being invited to open a door and step into tomorrow. The all-gas Advance Home, is sponsored by A.G.A. and *Parent's* magazine, built by Centennial Construction Company of Dallas in cooperation with Lone Star Gas Company, and opened October 1. On the other side of the door are startlingly new gas appliances and equipment presenting some completely unprecedented applications of gas. Most of the new equipment already is on the market. Practically every item is so brand-new as to be an exciting novelty to consumers. And nearly every application marks a dramatic advance beyond previous concepts of domestic gas use.

World's Fair Model Reveals Bold Design. *A.G.A. Monthly 43,* 9 (1961) Oct. (3 pp.)

New and unique design concepts with broad applications to future residential and commercial construction

will be incorporated in the gas industry's $6 million exhibit at the 1964-65 New York World's Fair.

Rate Making

New Directions in Gas Regulation. J. C. Swidler. *Gas Age 128,* 23 (1961) Oct. 12 (4 pp.)

The problem is, of course, how to apply the rate standards of the Natural Gas Act to producer rates. The history or the efforts which have been made to regulate producer rates need not be reviewed. The present vehicles for such regulation are the two area rate proceedings recently instituted by the Commission.

Safety

Effect of Chemical Structure on Spontaneous Ignition of Hydrocarbons. W. A. Affens, Jr., J. E. Johnson, and H. W. Carhart. *J. Chem. Eng. Data 6,* 613 (1961) Oct. (7 pp.)

Spontaneous ignition properties of combustible materials, particularly fuels and hydrocarbons, have been an important area of combustion research for over 50 years. This interest in spontaneous ignition is based on the important role which this phenomenon plays in the fire hazard in the handling and storage of combustibles, the performance of various types of combustion engines, and the elucidation of oxidation and combustion mechanisms of fuels, hydrocarbons, and related substances.

Organizing for Safety. G. E. Haddon. *Gas World 154,* 322 (1961) Sept. 9 (2 pp.)

Employers are directly and inescapably responsible for the well-being of employees. Thus accident prevention and safe conditions and methods of work are functions of management, and supervisors at all levels are responsible for the safety of those they control.

2. ENERGY SUPPLY AND ECONOMICS

Electricity

Power Efficiency Near Its Limit. *Business Week No. 1679,* 83 (1961) No. 4 (2 pp.)

Today's giant generators get nine to ten times the mileage out of a ton of coal that their ancestors did 60 years ago. But these dramatic gains have suddenly brought turbine generators near to the theoretical limits of efficiency; barring major breakthroughs, further rises will come only in driblets. The utilities hope to squeeze out whatever fractional gains in efficiency are still available by switching to brute size generators, which are cheaper to install per kilowatt of capacity, than several smaller units of equivalent capacity. The largest generators now operating—two 500,000-kw units —were turned on just last year, and already still larger models are being worked on at all three turbine-generator manufacturers.

Energy Resources

Ample Future Gas Supply Assured. A.G.A. Bur. Statistics. *A.G.A. Monthly 43,* 21 (1961) Oct. (3 pp.)

In 1945 net production of natural gas was 4.8 trillion cubic feet, in 1955 it was 10.2 trillion cubic feet and in 1960 it was 13.1 trillion cubic feet. It is estimated that net production of natural gas will be 18.5 trillion in 1970, 21.0 trillion in 1975, and 24.0 trillion cubic feet by 1980. Natural gas production has been estimated by the Bureau of Statistics to account for 33.1% of the total energy demand in 1970 and 34.1% by 1980, as contrasted to 28.3% in 1960 and 17.5% in 1950.

Baltic Oil Shale. *Petrol. Times. 65,* 577 (1961) Sept. 8.

In the 15 years between 1944 and 1958 five new shale oil deposits were opened up in Estonia, one with an annual capacity of 1 million tons. The average amount of oil recoverable by retorting is only 5 to 10% of the shale. The first plant for processing shale into gas was constructed at Kohtla-Jarve in 1948, and a refinery a year or two later. In addition to two gas pipelines, one 203 km (126 mi) long to Leningrad, and the other 150 km (93 mi) long to Talinn, were constructed. The share of shale oil in the fuel balance of the Soviet Union has increased from 0.3% in 1940 to 0.5% in 1950, and 1.0% in 1955. The proved reserves of oil shale in Estonia are now estimated at 9,900 million tons, and in the seven year period 1959-1965 the output is to be increased by 7 million tons to 16 million tons per year.

Estimating Gas Reserves With a Digital Computer. J. V. Crowley and D. Cornell. *Gas 37,* 105 (1961) Nov. (5 pp.)

There is a method for calculating gas reserves by means of a pressure decline curve using a digital computer. Computer calculations have many advantages. The principal benefits are the accuracy and speed of the calculations. A further advantage in gas reserves estimation is that computer solutions are impartial. Pressure decline curves must be fitted to field data.

Fuel Technology in the United States. H. Perry. *J. Inst. Fuel. 34,* 421 (1961) Oct. (15 pp.)

The United States is blessed with large resources of fossil fuels. Significant coal deposits ranging in rank from anthracite to lignite occur in 27 states. Petroleum and natural gas fields have been developed in 33 states. The remaining reserves of coals of all ranks except meta-anthracite amount to 1,700,000 million tons. At the end of 1959, the proved reserves of liquid hydrocarbons (crude oil and natural gas liquids) and natural gas were 36,242 million bbl (42 U.S. gallon) and 262,-596,593 MMCF of natural gas. On the basis of heating value the remaining reserves of solid fuels consist of about 91% of the fossil fuel resources of the United States. Reserves of fuels derived from tar sands, oil shale, and peat are excluded from the preceding computations. Tar sand deposits are small. Oil shale resources are important. Northwestern Colorado alone has more than 1,000,000 million barrels of shale oil in place, based on a minimum grade of 15 gal/ton, but none is being exploited now. No peat is used as fuel in the United States, although deposits occur in 30 states

and reserves are estimated to be 13,800 million tons of air dried peat.

Gas Processing and Refining: 80 Projects are Under Way or Planned. R. B. Bizal. *Oil Gas J. 59,* 107 (1961) Nov. 6 (4 pp.)

The Oil and Gas Journal's latest summary of construction shows more than 40 gas-processing plants underway or planned. These include 14 in Canada, most of them with large capacities. Helium recovery is also being pushed, and the contract has recently been let for the world's largest helium extraction plant at Liberal, Kansas.

Harnessing the Tides. *Mech. Eng. 83,* 75 (1961) Oct.

Harnessing the tides may soon become a reality, since French engineers have under construction the River Rance project that may prove an efficient and economical way to provide power from the sea. The mouth of the River Rance will be dammed, and as the tides rise, water will flow in through turbines in the dam wall. When the tides fall, water flows from the dam through the turbines once again, back to the sea. In each case the fall of water is utilized to produce electricity. The predominant advantage of the Rance project will be its ability to provide power when it is needed at peak consumption periods. In other installations, water mills have been devised to make some use of tidal currents, but the time when power is needed seldom coincides with the time of the tide. However, the operators of the Rance project can predict the tides accurately and correlate this with the pattern of expected peak demand. Water will be stored on one side of the dam during slack periods, and let out as needed.

Fuel Cells

Fuel Cells. E. Yeager. *Science 134,* 1178 (1961) Oct. 20 (9 pp.)

Many applications exist for a reliable, low-cost fuel cell operating on a practical fuel such as oil or natural gas. While definite progress is being made toward the development of such cells, they are not likely to become available in less than 10 years. Of particular significance is the potential use of fuel cells operating on hydrocarbons, or possibly methanol, in automobiles, trucks, and locomotives. If such applications do become widespread, the effect on various industries within the United States would be extreme. The benefits, other than economic, to be derived from such developments include freedom from noise and probably from the obnoxious exhaust gases associated with conventional engines. Various types, with associated research activities, are described.

Will Fuel Cells Make Propane the Power Source of the Future? R. Clay. *Butane-Propane News 23,* 74 (1961) Oct. (3 pp.)

The fuel cell should soon become a major energy source in America with almost every sector of society benefiting, and propane offers the best possibility of emerging as *the* fuel for fuel cells. These are the two most important conclusions to be drawn from a book entitled "Fuel Cells—Power for the Future." This study, economic and engineering in nature, is directed not only to the technical audience, but also to the general business audience.

Fuel Reserves

Fuel Futures. *Chem. Week. 89,* 38 (1961) Oct. 28 (2 pp.)

Developments in advanced hydrocarbon fuels were pinpointed at a recent meeting of the Society of Automotive Engineers in Los Angeles. No single hydrocarbon fuel meets the over-all specification for a high-temperature fuel; today a kerosene type petroleum mixture called JP-6 is being used to meet the immediate need for extreme high temperature resistance.

Geothermal Steam Sources

How the World's Hottest Hole was Drilled. E. T. Anderson. *Petrol. Eng. 33,* 47 (1961) Oct. (5 pp.)

Geothermal manifestations such as bubbling mud pots, fumaroles, and carbon dioxide wells have made this part of Imperial Valley geologically noteworthy for many years. Presence of the San Andreas fault to the north, the Obsidian Fault to the west, and molten magma between 8,000 to 10,000 ft indicated the presence of geothermal steam. Differing from other geothermal areas, the thermal gradient at this location appeared to follow a straight line on the order of 130°F/100 ft. After completion, the well was allowed to flow for 3½ days during which it produced 57,000 lb dry steam and 258,000 lb hot water per hr at well head conditions of 200 psig and 400 F. The water is highly mineralized and could prove very valuable from the standpoint of mineral products. Testing is still taking place in an effort to evaluate the potential of this newly found geothermal area.

Magnetohydrodynamics

Experiments With MHD Power Generation. S. Way, S. M. DeCorso, R. L. Hunstad, G. A. Kemeny, W. Stewart, and W. E. Young. *Trans. ASME. Ser. A.; J. Eng. for Power 83,* 397 (1961) Oct. (12 pp.)

This is a report on the development of an experimental MHD electrical generator which derives its energy from the combustion of a liquid fuel and oxygen. The fuel burned is a number 2 distillate oil in which a soluble potassium octoate is mixed to increase the degree of thermal ionization in the product gas. The actual generating volume is approximately 125 cu in. at the rating of 10 KW has been exceeded. Some of the broad construction features of the generator and problems arising during its operation are discussed. Fuel and combustion systems, fuel characteristics, and the electrical and magnetic aspects together with the theory of MHD power generation in a uniform duct is presented.

Magnetohydrodynamic Power and Propulsion. G. W.

Sutton and P. Gloersen. *Combustion 33,* 44 (1961) Oct. (7 pp.)

During the past year, the principles of magnetohydrodynamic power generation and propulsion have been experimentally verified. As yet, no practical generators have been demonstrated. For fuel burning generators, the materials lifetime and gas electrical conductivity must be increased without a sacrifice of efficiency. For propulsion, very high specific impulses have been successfully demonstrated for almost every type of device. Their compact size offers a distinct advantage over ion devices, and thus additional research appears to be justified. Article contains a 24 entry bibliography.

Petroleum Production

The Reconcavo Bahiano, Brazil's Only Petroleum Region. H. Grabert. *Erdol u. Kohle 14,* 692 (1961) Sept. (4 pp.)

The oil province of Reconcavo in Central Brazil, the only productive region of Brazil, holds a key position in the Brazilian oil industry because there is only small hope for major new fields in other parts of the country. The geological fundamentals and the development of the oil production in Reconcavo are discussed.

Underground Coal Gasification

Underground Gasification of Coal. A. E. Balfour. *Gas World 154,* 438 (1961) Oct. 7 (5 pp.)

Underground gasification is a procedure for converting coal lying in a seam into a combustible gas and bringing this to the surface with a view to utilizing its heat for power generation or some other industrial purpose. The basis of control of such operation depends principally on the measurement of pressures and temperatures and gas analysis, and since each experiment was costly with constantly changing conditions, considerable effort was made to record as much data as possible. Such operation means that maximum information had to be obtained from the recording and indicating instruments. The data taken consisted of temperature measurement, air and gas volumes, gas analysis, specific gravity, calorific value, water flow and water level.

3. NATURAL GAS AND PETROLEUM PRODUCTION

Drilling

Bit Records Show Progress in Drilling More Hole for Fewer Dollars. L. L. Payne, H. B. Woods, and R. S. Grant. *Oil Gas J. 59,* 120 (1961) Nov. 6 (5 pp.)

Every phase of rotary drilling has been studied in the past few years with the idea of drilling more hole for fewer dollars. The results have shown some definite changes in drilling practices and equipment. Changes are compared on toothed bits for the years 1957 through 1960, and show that drilling efficiency (bit footage and drilling rate) has improved about 2½% per year.

Offshore Core Drilling Hits Fast Pace. *Oil Gas J. 59,* 90 (1961) Oct. 23.

The M/V Torry, a self-propelled core-drilling ship working out of Long Beach, recently racked up an impressive record while drilling in the deep water off Santa Barbara and Ventura Counties, California. The ship completed 48 core holes at the rate of 1.7/day during a 29 day tour of duty. The holes went to an average of 524 ft into the ocean floor for a total of 25,160 ft of hole.

Gas Turbine Scores in Air Drilling. P. B. Bike. *Oil Gas J. 59,* 131 (1961) Oct. 23 (3 pp.)

First commercial operation of a prototype gas turbine to deliver compressed air for air drilling has been deemed a success. The turbine delivered up to 1,645 CFM of air at pressures up to 165 psi in drilling a well almost from the surface to a total depth of 6,603 ft. This volume of air resulted in excellent penetration rates, good hole cleaning, and superior cuttings recovery. The performance was as good or better than that which could be expected with the combined output of four commonly used piston-engine-driven compressors.

Solution to Survival. J. Skeehan. *Drilling 22,* 43 (1961) Oct. (6 pp.)

Is there a solution to the suicidal pricing tactics now rampant in the contract drilling industry? There is, but it must spring from within the ranks of the drilling industry itself.

Drilling, Rocket Flames

A Look at Rocket Flame Drilling. *Petrol. Eng. 33,* 66 (1961) Oct. (4 pp.)

The jet piercing process is based upon a characteristic of the rock known as "spallability". "Spalling" is cracking under heat due to the differential expansion of rock crystals from thermally induced stresses. Extensive research has indicated no single property accounts for the "degree of spallability" of a particular rock. Actually this process is brought about by directing or blasting the rock with a high velocity jet flame. This high heat intensity flame is generated by forcing oxygen and No. 2 fuel oil through nozzles in a downhole burner assembly. The burner resembles a jet-type drilling bit minus the cutting surfaces. Energy for piercing comes from combustion of process fluids.

Helium

Biggest Helium Plant Slated. *Oil Gas J. 59,* 93 (1961) Oct. 23.

Plans for the world's largest helium plant at Liberal, Kansas, were announced by Panhandle Eastern Pipe Line Co. and National Distillers and Chemical Corp. The operation will process a billion cubic feet of natural gas daily and will produce a billion cubic feet of helium a year. The United States Government has signed a 20-year contract to buy all of the Plant's production for $11.78/MCF.

Reservoir Engineering—

Production Rates and Ultimate Recovery Rates in Gasfields with Water Drive. K. Muller. *Erdol u. Kohle 14,* 695 (1961) Sept. (3 pp.)

An earlier calculation made on a gas reservoir model has shown the influence of the permeability K on pressure decline and water drive. In this paper, the calculation is modified for the case $K = 10$ md by a variation of the production rates. Pressure decline and water invasion are stronger with higher production rates, but the ultimate recovery is better with a higher than with a lower production rate, as the gas quantity corresponding to the residual gas saturation of the water flooded zone is smaller in the case of stronger pressure decline. For an estimate on the ultimate recovery factor both the residual and the initial gas saturation must be known, and also the pressure reduction compatible with a water drive. In the case of water invasion, production should be stepped up as far as possible and not interrupted.

Well Practice

Mud Additives in Deep Wells. J. Kelly, Jr. and D. E. Hawk. *Oil Gas J. 59,* 145 (1961) Oct. 30 (5 pp.)

Mud engineers have long suspected that some mud materials are not equal to the severe tests put to them by deep well drilling. Additives which control water loss are thought to degrade in the deep hot wells. Thinners seemingly fail to prevent viscosity, gel, and yield strength from climbing and some muds appear to be quite corrosive. A new circulating mud unit has been constructed to simulate conditions so that drilling mud can be studied at high temperature. The new unit simulates the heating, cooling, and aeration cycles actually encountered in the field mud.

4. GAS CONDITIONING AND LPG RECOVERY

Dust

Dust in Gas Streams. A. W. Doyle, N. W. Wiederhorn, and A. Swan. *Pipeline Eng. 33,* 54 (1961) Oct. (4 pp.)

Most important parts of a recommended sampling system are the sampling probe and nozzle. The probe, to be inserted and removed without objectionable gas leakage, should pass through a packing gland or some other type seal; and a particle detector, such as a filter or light scattering device should also be installed. The system should contain a valve, preferably downstream of the detector, to control the rate of sample flow. The sample should be metered before being returned to the pipeline or discharged to the atmosphere. The sample may be moved through the system by one of three mechanisms—a pressure pump, discharge of the sample to a line at lower pressure, or exhaustion of the sample into the atmosphere.

Flying Dusts and Fogs in City Gas: Their Detection and Composition. L. Creusot. *J. Ind. du Gaz 85,* 373 (1961) Aug.-Sept. (11 pp. French text.)

Around gum globules, the adhesiveness of which are well known, dusts swept into the mains can often cause damage or malfunction in the operation of gas appliances. This study is directed toward their systematic quantitative determination, classification, and other avenues of research.

Hydrates

Conditioning Natural Gas. L. L. Laurence, W. L. Scheirman, and K. G. Mitchell. *Erdol u. Kohle 14,* 734 (1961) Sept. (8 pp.)

The properties of natural gas hydrates, the conditions necessary for their formation, the measurement of dewpoints, the troubles caused by hydrates and water and the possibilities to combat them are discussed. In a more detailed manner, the following methods are dealt with: use of heat, of hydrate inhibitors, gas dehydration by expansion refrigeration (without and with inhibitors) and by liquid or granular desiccants. After description of each method, its advantages or features are summarized. A special chapter deals with the hydrocarbon dewpoint control which is becoming more and more important in treating natural gas.

Separators

Bolstering Gas-Cleaner Efficiency. *Chem. Week 89,* 109 (1961) Oct. 21 (2 pp.)

The new unit differs in three major respects from conventional wet electrostatic precipitators Koppers turns out, and from those made by Research-Cottrell and Western Precipitation Corp.; it features co-current liquid flow, a tangential liquid inlet, and a special shielded liquid outlet. Since Koppers is chary about discussing full details on the new unit until a prototype can be evaluated, the information on the precipitator was sifted from Kopper's patent U.S. 2,956,640.

Sulfur Removal

Gas Scrubbing for H_2S Removal and Methane Enrichment. A. M. Buswell. Proc. 15th Industrial Waste Conference, May 3, 4, and 5, (1960) *Eng. Bull. Purdue Univ. Eng. Ext. Ser. 106* (1961) 392 (13 pp.)

Soon after the sewage treatment plant at Miami, Florida was put in operation the digester gas was found to contain up to 600 grains H_2S/CCF or nearly 1% by vol. This was a serious matter since the gas was to be used for power production and 60 grains/CCF was the limit set by the gas engine manufacturers for use in internal combustion engines. The value of the gas was approximately $100/day. The high H_2S content of the gas was not anticipated since the city water was low in sulfates which are the general source of H_2S by reduction under anaerobic conditions.

Purification of Gas. J. H. Karchmer and M. T. Walker nee Eastwood (assigned to Esso Research and Eng. Co.) U.S. 3,000,988 (1961) Sept. 19.

A method is claimed for removal of carbonyl sulfide in the purification of an olefinic gas such as ethylene. Acidic gases and moisture are first removed, and then

the hydrocarbon gas is passed through granular (4 to 16 mesh) soda lime (NaOH and hydrated lime) and a carrier (kieselguhr, alumina, Floridin, or diatomaceous earth).

Separation of Carbon Dioxide from Gaseous Mixtures. D. B. Eastman and W. G. Schlinger (assigned to Texaco, Inc.) U.S. 3,001,373 (1961) Sept. 26.

A process is claimed for separation of carbon dioxide from a mixture with hydrogen. This consists of first cooling at 200 psig to condense the major portion, and withdrawing the CO_2. Residual gas containing small amounts of CO_2 is contacted with an organic liquid absorbent (Stoddard Solvent) at 500 psia and $-60°F$ to selectively remove CO_2. The rich solvent is expanded in heat exchangers to cool the incoming lean solvent. The cold scrubbed hydrogen is heat-exchanged with incoming raw gas for first-stage condensation of liquid CO_2. The CO_2 is expanded to further cool the lean absorbent after stripping the latter with air at 80°F.

5. NATURAL GAS TRANSMISSION

Automation

Data Transmission Simplified. F. V. Long. *Pipe Line Ind. 15,* 47 (1961) Oct. (3 pp.)

Data transmission isn't needed unless an automatic pipe line is desired, and even then, the volume of communications must be within certain ranges to make the digital system feasible. The greater the volume—the greater the speed of communications required. The speed of data handling is determined by the Baud rate, or "bits per second" which for practical purposes is the same thing. If a small quantity of data is processed, low speed transmission is sufficient.

Figure Separations This New Way. A. J. Weisenfelder, C. D. Holland, and R. H. Johnson. *Petrol. Refiner 40,* 175 (1961) Oct. (9 pp.)

The Θ method of convergence can be refined to minimize round-off errors and to include developments in the calculation of conventional and complex columns. The need for this was apparent in the extension of this method to absorbers. These developments include the detection and treatment of separated components, use of the bubble point procedure for all hydrocarbon systems, and the constant-composition method for enthalpies.

How Mid-America Controls Operations on a 2,184 Mile System from a Central Dispatching Center. K. Kridner. *Butane-Propane News 23,* 45 (1961) Nov. (4 pp.)

When a transport hooks up to a supply tank at one of Mid-America Pipeline Co.'s terminals, it has become the final link in a continuous pipe that may be 2000 or more miles long. There are no interruptions in this chain, which has its start on the plains of western Texas or eastern New Mexico. Withdrawals made from the terminal's storage tanks indirectly activate the system control center in Tulsa, Oklahoma.

Industrial Microwave: Pros and Cons. F. V. Long. *Gas 37,* 142 (1961) Oct. (6 pp.)

A properly designed and installed communications system operated and maintained for the company by competent company employees with sufficient knowledge of company procedures and needs, and having adequate means and authority to carry out indicated programs, can be a very powerful and useful tool in the efficient management of a wide-spread, integrated operation.

Multifunction Control System Regulates, Checks, Gas Dispatching. L. B. Lumpkin. *Oil Gas J. 40,* 120 (1961) Oct. 9 (3 pp.)

Measurement, control, alarm, deviation, command, and logging functions are performed by automatic, supervisory control system of Peoples Natural Gas Co. Ultramodern techniques of automatic and supervisory control are incorporated into the gas-dispatching system recently installed. It involves the remote operation of 5 major regulating and metering stations, Vinco, McKeesport, Chalfant, Mount Royal, and Blackhawk, all located in western Pennsylvania. They handle a peak load of more than 500 MMCF/day, for a quarter of a million customers in 274 communities in 15 counties.

Pipeline Construction

Pipeline Across the Mediterranean? O. Wolfe. *Oil Gas J. 59,* 91 (1961) Oct. 9 (4 pp.)

This article gives a mathematical analysis of the hydraulic problems that would be involved in designing the discussed gas line between North Africa and Spain. According to recent reports the 125 mile barrier between Mostaganem Bay in Algeria and Cartagena, Spain is about to be breached. It is French genius in this case which developed an answer to the difficulties of laying high-pressure pipe in very deep water. Its success may be ascribed to the development of the so-called "breathing" buoy which is attached to the pipeline at certain intervals and permits long sections of pipe to be lowered to the bottom in graceful, long-radius curves; and the development by French industry of 95,000-psi-yield pipe which is suitable for pipeline construction. It is proposed to build a multiple line system consisting of a number of 8⅝ in. diameter by 0.433-in.-wall parallel pipes. This pipe withstands an internal pressure of 5,700 psi at conservative rating and, also, is adequate against collapse under the 9,000-ft head of sea water.

Submarining the Mississippi. C. W. Morrow. *Gas 37,* 135 (1961) Oct. (4 pp.)

Columbia Gulf Transmission Company crosses the Mississippi River in the vicinity of Lake Providence, La. Its original crossing consists of two 24-in. and two 16-in. lines, installed in each of two parallel pipeline ditches, 1,000 ft apart. In view of these facts and because of the history of the river, Columbia Gulf's management decided to install another crossing as insurance for the pipeline's security and to provide for expansion.

Sub-Mediterranean Gas Pipeline Prospects. *Gas World 154,* 485 (1961) Oct. 14 (2 pp.)

Problems of a technical and economic character have to be solved before a project of this kind can be put

into effect. The first and most challenging of the obstacles to be negotiated is the question of transporting the gas across the Mediterranean. The award of a $7 million contract has been made to the BICC group to supply and lay a flexible submarine pipeline to convey natural gas from British Columbia to Vancouver Island.

XC-60 Pipe. K. Kridner. *Gas 37,* 139 (1961) Oct. (3 pp.)

Forty-seven miles of 20-in. pipeline stretched across the prairie of south Texas attest to the development of a new high strength pipe steel. This steel uses the element columbium (niobium) to achieve a 60,000 psi minimum yield strength. National Steel now has filed application with the patent office for use of columbium as an additive to semi-killed steels—to a maximum of two tenths of one per cent. Early in 1961, Natural Gas Pipeline completed construction of its 20-in. pipeline from Hebronville to Falfurrias in South Texas—a distance of 47 miles. This 47-mile installation rates classification as the strongest and probably the freest of weld defects of any natural gas transmission line ever built. Construction men have found that XC-60 pipe yielded to bending as easily as conventional pipe.

Pipeline Materials

Columbium Additive for Pipeline Steels. A. G. Barkow. *Gas Age 128,* 32 (1961) Oct. 12 (7 pp.)

Economic pressure as well as public safety demands have forced the pipe-line industry to take a long look at presently available materials and investigate the possible development of new and improved materials which will fulfill this dual requirement. Larger and longer pipelines, operating at higher pressures, have demonstrated the economic feasibility of higher strength material and the resulting lighter-wall pipe, even where an alloying element may be necessary to achieve this purpose. Columbium as an additive to steel has a strong affinity to carbon and also acts as a ferrite former on the crystalline structure of the steel. The carbide forming tendency of this element is so great that it frequently is in the structure as an undissolved carbide and in this way reduces the hardenability of the steel, a valuable adjunct to weldability. It is possible to decrease the carbon content without lowering the strength, and the reduction in carbon produces a more weldable material in the high strength group.

Pipeline Operations

Dixie's New 1,080-mile LPG Line Can be Considered a "Tight" System. P. Reed and J. P. O'Donnell. *Oil Gas J. 59,* 96 (1961) Oct. 16 (5 pp.)

Receipts and deliveries must be in balance. Line uses variable speed couplings, packaged switch gear, extra-length joints, and record-size, shop-fabricated tanks, and sponge-type scrapers to dry the line. Main-line contractors prepare the common sites for stations, terminals, and install the prefabricated piping. The 1,080 mile, 65,000 bbl per day Dixie Pipeline Co. system will stretch from Mont Belvieu, Tex., to Raleigh, N. C. is described as a "tight" line.

Pipeline-Simulation Program Recognizes Batch, Terrain, and Temperature. W. A. Zama. *Oil Gas J. 59,* 138 (1961) Oct. 23 (4 pp.)

The simulator provides in seconds, answers to technical questions which, under other conditions, would require days of manual calculations. Recognition of oil batches and temperature effects constitutes the major refinements of earlier computer programs for pipeline simulation. The program described has simulated operation of several of Shell's main trunk lines to determine line capacities and operating pressures. The need for increased accuracy of oil pipeline simulation has required the inclusion of additional variables.

Pipeline Systems

Special System Controls Special Line. R. Gode. *Pipeline Eng. 33,* 46 (1961) Oct. (4 pp.)

Twenty separate products are handled in a standard batching cycle by the new Calnev Pipe Line Co. system that extends from Colton, Calif., to Las Vegas, Nev. Design of the control system takes into consideration further problems resulting from rugged terrain, varying elevations, remote locations, and minimum operating personnel. Result is a system that permits each item (supervisory, telemetering, controls, and interface detection) to operate independently. Loss of communications or malfunction of any part will not necessarily shut down the whole operation. All parts are so tied together, that the dispatcher can operate the line to best advantage and deliver products according to shippers' requirements.

Telemetering

Telemetering. M. T. Nigh. *Pipeline Eng. 33,* 51 (1961) Oct. (3 pp.)

Systems engineering is opposed to past practice which consisted of perfectly engineering each instrument or component regardless of the entire system. In its present concept systems engineering considers overall points as to best location for analog-to-digital conversion and the distance problem in the case of pipelines, the question of degeneration of accuracy of measurement signals, and benefits contributed by the computer.

6. GAS AND LPG STORAGE

Gas Holders

World's Largest Refrigerated LPG Storage Facility. G. Lillquist, W. T. Vann, and B. Maher. *Am. Gas J. 188,* 24 (1961) Oct. (7 pp.)

The world's largest refrigerated storage facility for liquid propane is now in service at the Dakota County Peak Shaving Station of Minneapolis Gas Company. Addition of the huge above-ground cryogenic storage tank, which serves a new 750,000 CF/hr propane-air gas plant on the same site, nearly doubles Minnegasco's propane storage capacity. Simultaneously, Minneapolis Gas began formulating plans for a propane-air plant on

the same site. This winter the new station will have a mixing capacity of 1400 Btu propane-air gas equivalent to 750,000 CF of 1000 Btu natural gas per hour. The propane-air mixture will be discharged into natural gas lines at 175 psig.

The Thermal Conductivity of Foamed Plastics. R. E. Skochdopole. *Chem. Eng. Progress 57,* 55 (1961) Oct. (5 pp.)

Understanding how factors affect thermal conductivity is important in insulation applications. The effects of foam properties and environment on the mechanisms of heat transfer are presented. A low thermal conductivity is one of the most important properties of foamed or cellular plastics, particularly those of lower density. The current availability of a large number of foamed plastics with widely differing properties makes it desirable to understand how foam properties and environment influence the thermal conductivity. While this article is concerned mainly with cellular plastics, the treatments should hold for other cellular materials as well.

Liquefaction

Coming Up: Commercial Transport of LNG. *Oil Gas J. 59,* 123 (1961) Oct. 9 (4 pp.)

Methane Pioneer's pilot step proved it can be done. Next step is to build the necessary large, fast, double hulled ships necessary to convert the demonstration into a commercial venture based on large volumes. Conch International Methane, Ltd. is engaged in the next step of turning this into a commercial proposition based on the transportation of large volumes. Current thinking is directed towards the building of about 167 thousand barrel ships; large, rather fast, fine double hulled ships, with a block coefficient of 0.71. These would carry the cargo in nine prismatical, self-supporting tanks, inserted into three insulated holds and keyed at top and bottom. Propulsion will be by steam turbine machinery.

Cryogenic Gases. *Chem. Week. 89,* 55 (1961) Oct. 14 (19 pp.)

The air separation column is the heart of the cryogenic industrial gas industry. The column fractionates liquefied air into its components: oxygen, nitrogen, argon, neon, krypton, and xenon. Some helium is also produced this way. Similar "cold box" techniques are employed in large scale helium (from natural gas) production and in purifying certain hydrogen and hydrocarbon streams. These procedures have been adopted to manufacture of liquid hydrogen and will be the key to successful launching of proposed multimillion dollar projects for transporting and storing liquefied natural gas. These gases account for sales of $520 million/year. The business has tripled in the last 10 years, and should double in the next 10. But growth is bringing more competition and more problems.

Liquefied Methane as a Source of Future Supply for the West Coast. J. R. Fraser. *Gas Age 128,* 27 (1961) Oct. 12 (3 pp.)

The technology is proved, the gas reserves are available and under the right set of conditions, the delivered price on the Pacific Coast is fully competitive with available gas supplies. Union and Ohio Oil discovered in 1959 enormous reserves of natural gas in Alaska. This gas, which is 99.6% pure methane, is located on the Kenai Peninsula, some 60 mi from Anchorage. An engineering firm was hired in 1960 to make a thorough study of the technical and economic feasibility of marketing Alaskan gas in the form of LNG. As a result, detailed plans for a large scale venture have been made. The technology gained through coordinated research has proved technical capability for the job.

Multiple Layer Insulation for Cryogenic Applications. R. H. Kropschot. *Cryogenics 1,* 171 (1961) Mar. (7 pp.)

The use of multiple layer insulation for cryogenic applications is discussed. This type of insulation is fabricated by building up layers of a poor conductor (i.e. glass fiber) spaced alternately with a good reflector (i.e. aluminum foil). Results are given for many applications, the combination of multiple layer insulation and high vacuum is far superior to previous cryogenic insulations. The apparent mean thermal conductivity between 300°K and 20°K for the best samples tested is less than 0.5μW/cm. deg. K. Typical uses for this material include the insulation of cryogenic vessels, transfer lines, and space vehicles.

PVC Plastisol Looks Like Hawaii's Answer to Tank Corrosion. *Butane-Propane News 23,* 51 (1961) Nov.

Corrosion is particularly severe in Hawaii. The damp warm climate has created a severe corrosion problem because of high ambient humidity, salt air, and consstant trade winds. To solve this costly problem, the Honolulu Gas Co. Ltd., through its Isle-Gas Services Division now coats its domestic LPG tanks with a spray applied PVC (polyvinyl chloride) plastisol.

Underground Storage

Hole in the Ground Stores Frigid LNG. *Oil Gas J. 59,* 60 (1961) Oct. 16 (2 pp.); *Chem. Week 89,* 71 (1961) Oct. 21; *Gas Age 128,* 43 (1961) Nov. 9 (5 pp.)

Conch International Methane, Ltd., and Constock-Pritchard Corp. demonstrated their "frozen earth" technique at a site near Lake Charles, La. On exhibit was an 850 bbl storage pit capped by an insulated aluminum roof. The pit has no lining. The −258° liquid is contained only by the frozen earth, which forms an impermeable barrier and prevents escape of the product.

LPG Underground Storage Capacity Leaps 25%. R. B. Bizal. *Oil Gas J. 59,* 84 (1961) Oct. 16 (7 pp.)

Increased production and LPG sales spur further underground storage. Industry has completed 14 new caverns during the past 6 months, and another 18 are now under way. A record inventory has built up this summer, awaiting winter's tug. The Oil and Gas Journal's 8th annual survey shows existing capacity has climbed to 67,428,960 bbl. Add to this another 9,022,620 bbl of new capacity currently being added and the total becomes 76,451,580 bbl or about 25% higher than the comparable figure last year.

New LPG Storage Cavern. B. C. Altman. *Gas 37,* 74 (1961) Oct. (5 pp.)

The Metropolitan Utilities District of Omaha initiated geological studies in June 1959 to determine if a suitable formation could be found for construction of a mined storage cavern. Core samples were taken on a 40-acre site, located near the southwest edge of the city adjacent to the district's new construction and materials storage center and approximately two-thirds of a mile from one of the major 100 psig distribution mains. Construction of a 7.5 million gal. storage cavern was begun in September, 1959. The main shaft and 3 auxiliary holes were completed in approximately 3 months with the setting and grouting of the 42 and 12 in. steel casings. Actual mining of the network of 10 ft wide and 25 ft high tunnels was completed in June 1960. Construction of a similar cavern storage plant to be completed in 1963 is scheduled to begin this fall. Completion of the new plant will raise the total storage capacity to over 16 million gal., which will permit Metropolitan Utilities District to rely on propane-air production for 35% of its peak day requirements.

7. MANUFACTURED GAS AND CHEMICAL PROCESSING

Catalysts

Alumina Catalyst and Support. XII. The Effect of Intrinsic Acidity of Aluminas upon Hydrogen-Deuterium Exchange. H. Pines and J. Ravoire. *J. Phys. Chem 65,* 1859 (1961) Oct. (3 pp.)

Extensive studies carried out have revealed that alumina has intrinsic acidic properties, and that the strength of the acid sites depends upon the methods used for the preparation of alumina. Alumina prepared by hydrolysis of aluminum isoperoxide catalyzed the isomerization of cyclohexene to methyl cyclopentenes, whereas alumina prepared from potassium aluminate did not affect such isomerization. It was demonstrated that aluminas of different intrinsic acidities exert a deep influence upon the isomerization of alkenes and dehydration of alcohols; they also influence the catalytic properties of molybdena-alumina, chromia-alumina, and platinum-alumina catalysts.

Check Ways to Measure Catalyst Size. M. tenBroecke, D. H. C. Meun, and L. Moscou. *Petrol. Refiner 40,* 139 (1961) Oct. (6 pp.)

The particle size distribution of cracking catalyst is most important for proper fluidization in the unit. In the past a number of methods have been developed and adopted for determination of the particle size distribution. Each of these methods shows disadvantages, and the results obtained with one method often differ considerably from those with other methods, which has made comparison of particle size data difficult. At the Ketjen Laboratories various of these particle size distribution methods are in use for production-control of fresh catalyst and service testing for equilibrium catalyst for the refineries.

Hopcalite-Catalyzed Combustion of Hydrocarbons Vapors at Low Concentration. J. E. Johnson, J. G. Christian, and H. W. Carhart. *Ind. Eng. Chem. 53,* 900 (1961) Nov. (3 pp.)

A study was made of the efficiency of hopcalite to catalyze the combustion of hydrocarbons and other organic vapors at low concentrations and at high flow rates. At concentrations ranging from about 20 to 125 mg/cu m, selected aromatic, alicyclic, and aliphatic hydrocarbons, with the exception of methane, were oxidized to CO_2 essentially completely at 350°C. At about 200° oxidation was not complete, the extent being dependent upon structure. The combustion of methane was incomplete even at 450°C. Certain selected oxygenated compounds were oxidized more readily than the hydrocarbons.

The Role of Supports in Catalytic Hydrogenation. Pt. I. Activation Effects of Various Oxide Carriers on Palladium. E. B. Maxted and S. I. Ali. *J. Chem. Soc.,* 4137 (1961) Sept. (4 pp.)

Zirconia, thoria, alumina, and titania have been found to have a considerable activating effect when used as supports for palladium in the liquid phase hydrogenation of cyclohexene in alcohol at 20°C. The activity of the supported catalyst, containing a constant amount of palladium, first rises to a peak value and subsequently falls as the amount of the support is further increased. This increase, with zirconia and thoria, amounts at the peak point to about 24 times the unsupported value, and with alumina and titania to about 22 times this figure. It was also noticed that, when different specimens of the same support were used, there was a marked difference both in the activities of the catalysts and in the location of the peaks in the graphs; further, in addition, to the effect of the chemical nature of the support, the activity is also influenced by the surface area, by pore volume, and by other factors.

Fischer-Tropsch

Further Studies of the Fischer-Tropsch Synthesis Using Gas Recycle Cooling (Hot-Gas-Recycle Process). J. H. Field, D. Bienstock, A. J. Forney, and R. J. Demski. *U. S. Bur. Mines Rep. Invest. 5871.* (Washington, D. C.: U. S. Govt. Print. Off., 1961.)

Good temperature control with a pressure drop of less than 0.5 psi/ft of catalyst bed of steel turnings was obtained by operating with a recycle to fresh feed ratio of 20 and by splitting the total gas flow and injecting portions into the reactor at different entry ports. At an hourly space velocity of 1,000, 90% of the feed gas was converted at 300 to 320°C. At a space velocity of 1,500, 88% was converted. The proportion of gasoline in the hydrocarbon product ranged from 55 to 66%. The finished gasoline with 3 cc tetraethyl lead had research octane rating from 90 to 96. Synthesis of gasoline in a hot-gas-recycle process is preferable to processes using oil as coolant. At the higher temperatures possible in the hot-gas system, a larger percentage of the hydrocarbon product is gasoline. Carbon steel turnings with a void volume of 88-90% were satisfactory

catalysts; greater volumes in turnings or steel wool did not produce such activity.

Fluidized Beds—Oil Shale

The Production of Steam, Electricity, and Hydraulic Hardening Binders from Oil Shale by the Rohrbach-Lurgi Process. G. Friese. *Erdol u. Kohle 14,* 702 (1961) Sept. (2 pp.)

A new process for the production of hydraulic hardening binders of high strength from oil shale in fluidized beds is described. The waste heat may be used for generating steam and/or electricity. The process is already being utilized in a large scale plant.

Gas Liquor

Gas Liquor as a Larvicidal Agent. F. C. Sherriff. *Gas J. 308* (1961) Oct. 4.

Experiments in the control by gas liquor of the larvae of parasitic worms which cause such havoc among cattle and sheep have been carried out. Hitherto the only treatment for parasitic infestation has been to control, with such drugs as are available, the adult worms within the body of the animal. It seems likely that gas liquor restricts the development of large numbers of larvae in the grass—other inferences may be drawn from these tests: such control as has been established is probably only temporary in any single application of liquor, though cumulative over the years since stock is being subjected to less and less infection and are returning less infective larvae to the soil. Re-infection of treated pasture can take place when grazed by infected stock.

Hydrocarbons

"Oil" Refinery, New Style, Geared to Hydrocarbons Trend. N. P. Chopey. *Chem. Eng. 68,* 160 (1961) Oct. 16 (3 pp.)

A novel Canadian refinery may be the pace-setter for a new look in hydrocarbons production. It yields gasoline and distillate fuels with minimum processing while providing a logical outlet for byproduct condensate from natural gas.

Hydrogen Production

Help for Hydrogen-Hungry CPI. *Chem. Week 89,* 61 (1961) Oct. 21 (3 pp.)

Three firms disclosed recently that they have processes or plants under development to steam reform naphtha to make hydrogen. If such efforts attain commercial status, naphtha will become an alternate raw material to natural gas or fuel oil in hydrogen manufacture. Its significance is that a new tool is ready to help processors supply mounting worldwide demands for hydrogen. In this country alone hydrogen consumption is expected to expand from 1.9 MMCF/day in 1960 to 3.7 billion in 1965.

Large Scale Liquid Hydrogen Production. P. C. Vander Arend. *Chem. Eng. Progress* 57, 62 (1961) Oct. (6 pp.)

The overall process for producing liquid hydrogen in tonnage quantities is described. Millions of pounds have been produced and handled safely. The history of liquid hydrogen during the past ten years is marked by the growth of low temperature engineering from the laboratory to full scale industrial production. Prior to 1956-57, economy of manufacture and handling had not been seriously considered and it was thought that considerable technical difficulties existed and had to be solved before successful tonnage of liquid hydrogen could be produced.

Organic Sulfur

Organic Sulfur Compounds: V. Alkyl Ammonium Thiolate and Peroxide Salts; Possible Intermediates in Amine Catalyzed Oxidation of Mercaptans by Hydroperoxides. A. A. Oswald, F. Noel, and A. J. Stephenson, *J. Org. Chem. 26,* 3969 (1961) Oct. (6 pp.)

Aliphatic amines catalyze the reaction of mercaptans and hydroperoxides to yield the corresponding disulfides, alcohols and water. The formation of alkyl ammonium salts of mercaptans and hydroperoxides was studied as possible explanation of this catalysis. Alkyl ammonium peroxides form a new class of hydroperoxide salts. They react with aromatic mercaptans at a very fast rate to yield alkylamines plus the same products as the amine-catalyzed mercaptan oxidation by hydroperoxide.

Petrochemicals

For Ethylene Oxide its Uphill for the Second Billion. J. Gorden. *Petrol. Refiner 40,* 159 (1961) Oct. (7 pp.)

Since its introduction for antifreeze in 1929, this ethylene glycol outlet has also developed into a billion lb/yr market, with an annual retail volume of $300 million. In this time glycol has captured 91% of the total antifreeze volume, mostly at the expense of methanol, a more volatile product. But future signs indicate a slower rate of increase in this dominant market. With the entire automotive industry in a state of flux, practically all producers of ethylene oxide and glycol have moved to diversify. Further major expansion is not looked for until the situation clarifies. Petrochemical companies meanwhile will benefit from continued improvement of oxidation processing and from application of the ethylene oxide derived products in their production and refining operations.

High Temperature Curing Applied to Butadiene-Styrene Systems. A. G. Lomax. *Gas World 154,* 61 (1961) Oct. 21 (2 pp.)

Curing with a naked gas flame gives a good film. Normal stoving techniques can be used with these materials but these methods are not suitable for the rapid application of fairly thick, chemically resistant coatings. Two high temperature curing methods, flame and jet curing were developed to cope with this problem. Practical application of these techniques is covered and mention is made of both continuous coating and individual hand spray methods. The external coating of steel pipes for underground pipelines is discussed and the results compared with competitive materials. When a few remaining technical problems have been solved, flame or jet cured coatings will offer a corrosion resistant system to steel

fabricators and pipe manufacturers at a highly competitive cost.

Mercury Photosensitized Interaction of Ethylene and Propane. J. R. Majer, B. Mile, and J. C. Robb. *Trans. Faraday Soc. 57,* 1692 (1961) Oct. (11 pp.)

When ethylene and propane are irradiated in the presence of mercury vapor, isopentane is formed. The amount of isopentane is higher than would be anticipated from a radical reaction. The yield is not lowered by the addition of sulfur hexafluoride as are yields of competing radical reactions. The difference in behavior of the yields of isopentane and 3-methyl-butene-1 suggests that they do not arise from pentyl radical disproportionation. Deuteration studies suggest that some of the isopentane is formed by a non-radical reaction which may involve direct insertion of the excited ethylene molecules into the C—H bond of propane. The non-radical reaction is responsible for about 30% of the isopentane formed at pressures of ethylene below 40 mm.

Oil and Natural Gas as Petrochemical Base Stocks. F. Schmeling. *Erdol u. Kohle 14,* 765 (1961) Sept. (5 pp.)

This paper is a contribution to the general professional training program for the personnel of member firms of the German Petroleum Industry Association. It shows the development of the petrochemical industry in parallel to the carbochemistry under German aspects. Olefins and aromatic hydrocarbons are produced by the usual kind of petroleum processing as well as by specially developed procedures. They open simpler and more economical ways for organic syntheses, based on the present ample supply of crude oil in the world.

Petrochemical Synthesis and Metallo-Organic Compounds of Nickel. P. D. Wilmot. *Petrol. 24,* 376 (1961) Oct. (6 pp.)

Both organic and inorganic chemistry and the concepts and techniques of physics converge in the study of organo-metallic complexes and many new patterns of chemical behavior have been shown. Some of these phenomena have already found application in petroleum refining and industrial chemical synthesis. One of the earliest industrial applications of metallo-organic chemistry was the development of the refining of nickel by the Mond carbonyl process at the end of the last century. Since that time there have appeared many new applications which demonstrate the flexibility of metallo-organic chemistry of nickel. Certain of these applications are described.

Slow Oxidation of Hydrocarbons in the Gas Phase. Pt. I. Reactions During the Induction Period of Isobutane Oxidation. A. P. Zeelenberg and A. F. Bickel. *J. Chem. Soc. 4014* (1961) Sept. (6 pp.)

The slow oxidation of isobutane in a static system at about 300° has been investigated with special reference to the chemical changes that occur during the induction period. Analysis by means of gas-liquid chromatography with sensitive detectors showed that the concentrations of many primary products (isobutene, isobutene oxide, propionaldehyde, acetone, methanol, propene, propene oxide, acetaldehyde, etc.) increase according to a relation $C = C_0 e^{\phi t}$. For nearly all products the branching factor ϕ was found to have the same value. The reactions during the induction period which are less complex than those in later stages, have been formulated as a degenerate chain-branching mechanism involving chain-propagation reactions of both isobutyl and t-butyl radicals. During the induction period the products are formed by intramolecular decomposition of the butyl-peroxy-radicals.

Pyrolysis

The Role of Surfaces in the Pyrolysis of *n*-Butane. J. H. Purnell and C. P. Quinn. *J. Chem. Soc.* 4128 (1961) Sept. (5 pp.)

The effects of a four-fold change of the surface: volume ratio (A/V) of the reaction vessel and of 7 types of surface on the rate of pyrolysis of *n*-butane have been examined by gas-chromatographic product analysis. It has been found that, up to 9% conversion of *n*-butane identical and reproducible rates are observed at all values of A/V and for clean, KCl-coated, and etched pyrex vessels. A magnesium perchlorate coating leads to a large initial acceleration of rate, probably due to decomposition of the perchlorate to oxide; when this is complete the rate is less than with the other types of surface. Conditioning by carbon reduces the reaction rate considerably and the effect is cumulative. It is concluded that in clean, KCl-coated, and etched vessels the reaction is homogeneous, but that in magnesium oxide or carbon-coated vessels heterogeneous termination processes may be important.

Radioactivity Applications

Ethane Radiolysis at Very Low Conversion. K. Yang and P. L. Gant. *J. Phys. Chem. 65,* 1861 (1961) Oct. (5 pp.)

Decomposition of excited ethane ions and subsequent ion-molecule reactions were sufficient to account for the contributions from the non-radical processes to the yields of H_2, CH_4, and CH_3, thus confirming earlier correlations between mass spectra and radiolysis data. In connection with the gas phase dosimetry, it was shown that the hydrogen yields in ethylene and propylene radiolysis give good reproducibility without elaborate purification and that these yields are independent of conversion. The use of these systems as secondary dosimetric standards is recommended particularly for gas phase radiolysis work at very low conversion.

Sulfur Corrosion

A Study of Sulfur Reactions in Furnace Deposits. M. Weintraub, S. Goldberg, and A. A. Orning. *Trans. ASME, Ser. A.; J. Eng. for Power 83,* 444 (1961) Oct. (7 pp.)

A study was made of absorption of sulfur from synthetic flue gas by coal ash. When fly ash was placed in a temperature gradient like that in a deposit on a boiler tube, maximum absorption was found at 1100°F. The amount of absorption was highest for fly ash from furnaces in which serious deposit formation was ob-

served. It was also highest for fly ash containing the highest content of sodium and potassium. The sulfur is probably absorbed as mixtures of normal sulfates, pyrosulfates and such compounds as potassium-ferric trisulfate. A liquid phase of these compounds in contact with tube metal causes corrosion. The maximum sulfur absorption found at 1100°F coincides with a maximum at the same temperature that has been observed for external tube-metal corrosion.

Coal Gasification Apparatus. D. B. Eastman and B. H. Sage (assigned to Texaco Inc.) U.S. 3,000,711 (1961) Sept. 19.

Apparatus for the gasification of coal is claimed in which a vertical cylindrical pressure vessel is used, with a reaction chamber for pulverized coal, oxygen, and steam at the top, and a lower slag quenching zone is placed at the base. The reactant and products discharge downwardly through an annular refractory deflector into the slag quenching chamber. Back flow of gas and heat loss are prevented by maintaining a deflector area of 0.4 to 0.9 times the cross-sectional area of the reactor.

Synthesis Gas

The P-9 Generator for Town Gas from Light Petroleum. A. Bolzinger. *Gas u. Wasserfach. 102,* 1065 (1961) Sept. 29 (4 pp.)

A plant is described for production of town gas from light petroleum fractions, with use of waste heat boilers for steam production. Development of continuous outside heated catalyst tubes, automatic-controls, and use of high-sulfur oils is mentioned. Features of heat exchange and operation of the new cyclic system are given.

8. GAS DISTRIBUTION

Distribution Systems

The New C.W.G. Plant at Sydney; Some Instrumentation and Control Aspects. J. G. B. Whitelaw. *Gas Times 95,* 27 (1961) Sept. (3 pp.)

The Mortlake works of the Australian Gas Light Company contains a central control room with a comprehensive arrangement of instruments for two distinct purposes. The first called for centralized presentation of all important plant operating characteristics and alarm conditions and the provision of automatic control systems which would give a self regulating plant up to an economically feasible point. The second was to provide for the recording of relevant data which could be used subsequently for plant efficiency checks and as a guide to operational adjustments.

Tools of Economic Analysis. C. V. Kroeger. *Gas 37,* 60 (1961) Nov. (5 pp.)

According to American Gas Association statistics, in 1959 distribution system maintenance costs constituted 5.9% of total operating expenses and 84.8% of all maintenance for straight natural gas distributing companies (excluding transmission and combination companies). These compare with a 10 year average of 5.7% total expense and 83.8% of total maintenance. It can be seen that virtually all of the maintenance expense of a straight natural gas distributing company is in distribution system maintenance. Ratio analysis establishes reference points for management, investor, and utility commission. It forms the point of departure for detail review of the individual company's operating and maintenance practices.

Fluid Flow

Analysis of the Measurement of Turbulent Boundary Layers by Means of Wall Relations. *Ing. Arch. 29,* 4,291 (1960) Aug. (10 pp. German Text) from *Appl. Mech. Rev. 14,* 797 (1961) Oct.

In previous papers the author developed a formula for velocity distribution in turbulent boundary layers with pressure gradient based on Prandtl's mixing-length theory and compared it with experimental results of Nikuradse. In this paper comparison is made with experiments of Fage, Sandborn, and Slogar, and Schubauer and Klebanoff. Good agreement is shown for the first two comparisons.

R. C. Roberts

Calculation of Laminar Forced Convection for a Fluid Flowing in a Pipe at Small Peclet Numbers. B. S. Petukhov and F. F. Tsvetkov. Inzhener. Fiz. Zh. 4 No. 3, 10 (1961) Mar. (8 pp.) *Appl. Mech. Rev. 14,* 810 (1961) Oct.

Paper is concerned with the elucidation of the very topical problem of the discrepancies between calculation and experiment relating to the transfer of heat by laminar convection to molten metals flowing through pipes at very low Peclet ($Pe = Re \times Pr$) numbers. The reasons for the discrepancies are sought in the effect of axial heat conduction which is usually disregarded, and which becomes small at $Pe \approx 10$ or more. The problem is solved by dividing the tube into n concentric annuli and by writing down the heat balance equations for them.

J. Kestin

Comments on How Good Are Good Fluid Flow Measurements. H. S. Bean. *Gas 37,* 70 (1961) Nov. (3 pp.)

The uncertainty in the measurement of any fluid flow will depend upon all of the elements or factors by which the flow is determined. No general statement seems possible. To try to give a general statement could be very misleading. In any one group or system there will be similar elements or factors and to that extent some generalizations may be possible. The uncertainties which have been considered are those which arise from the seemingly unavoidable imperfections in instruments, tools, mechanisms, and techniques.

A Numerical Solution of the Laminar Boundary-Layer Equation. I. V. Petukhov. Soviet Phys.-Doklady 5, 3, 489 (1960) Nov./Dec. (4 pp.); Trans Dokladi Akad. Nauk SSSR (N.S.) 132, 2, 307 (1960), May, Am. Inst. Phys., Inc. N. Y. *Appl. Mech. Rev. 14,* 797 (1961) Oct.

The incompressible-boundary-layer problem is approached as if it were an inviscid flow but with a different surface of the body, i.e., a displacement of the surface. The governing equation *k*n terms of these fictitious

velocity components is that of a parabolic type. The methods of characteristics and successive approximations are then used to match the unknown displacement. No numerical illustration is given.

L. N. Tao

A Study of Fluid Flow Through Flexible Orifices. R. D. Ulrich, W. E. Fontaine, and O. W. Witzell. *ASHRAE J. 3,* 63 (1961) Oct. (6 pp.)

Flexible orifices are of interest because of the large variety of flow rate-pressure drop relations which may be obtained by various designs of the orifice and the method of supporting the orifice. The phenomenon of decreasing flow-rate with increasing pressure suggests the use of these orifices as devices for the regulation of flow. Attempts have been made to use these orifices in refrigeration systems.

Mains

Distribution Development. *Am. Gas J. 188,* 50 (1961) Oct.

Peoples Gas Light and Coke Company, Chicago, has completed work on the southern section of its new $20,000,000 interstation gas main. A total of 4,300 tons of 36 in. steel pipe was used for the 11 mile, $9,000,000 segment that extends from the Company's Calumet Station, 3200 E. 98th to 58th Street and Damen Ave. The completed work is the second phase of a three year project.

Gas Main Under the River Severn. R. Pratt. *Gas World 154,* 479 (1961) Oct. 14 (4 pp.)

The river Severn is not generally navigable in the section under consideration and is strongly tidal. From a river bed level of 12 ft ordance datum (o.d.) the water level varies from 16 ft o.d. low summer level to an average winter level of 20 ft o.d. Maximum flooding conditions of 36 ft o.d. were experienced in 1947 with a general land level of 30 ft. The current speed is 5½ to 6 knots (6.3 to 6.9 mi) and the river bed is composed of hard blue and brown clay. A strong scouring action of the river bed occurs in the Middle Rea area. To obtain a reasonable outlet from the river on the north-west bank, the area in which the crossing was acceptable was limited to a section 600 yards in length. Three provisional crossing points were selected and a firm of specialist underwater mainlaying contractors were consulted on the practicability of a submarine crossing.

Maintenance

Storing Town Gas During Holder Repairs. *Gas Times 95,* 22 (1961) Sept. (2 pp.)

It was necessary to devise a means of temporarily storing gas during the periods when each holder was out of commission. It was decided that the cheapest form of temporary storage would be in the form of an inflatable rubber bag capable of throwing a minimum district pressure of approximately 4 in. wg. Some form of weighted board, together with supporting framework, was required upon which kentledge could be placed in order to maintain the required pressure during all stages of inflation. This structure could be easily dismantled, transported, and re-erected when required.

Study Hopes to Forestall Fatigue Cracks in Piping. *Oil Gas J. 59,* 95 (1961).

Fatigue cracks in piping around reciprocating compressor stations will someday be much less frequent and much less severe. This promise is held out by the results of an investigation into the behavior of branch connections under cycle loads. It is incomplete, but several conclusions are indicated that should go a long way in helping to design systems against fatigue failures. This investigation is being conducted at Battelle Memorial Institute, under the auspices of the American Gas Association's Pipeline Research Committee and the NG-11 Supervisory Committee.

Metering

Meter Reading by Digital Scanning. F. V. Long. *Pipe Line News 23,* 49 (1961) Oct. (4 pp.)

A very useful piece of equipment has been adapted from aviation practice. It is a device which can scan a meter face, which is essentially an analog device, and automatically convert it into a digital output which can be "read out" either locally on a digital display panel or telemetered to some distant point.

Vacuum Proving Large Meters with Flow Provers. H. V. Beck. *Gas 37,* 86 (1961) Oct. (2 pp.)

The shortcomings of blower testing can be circumvented by placing the flow prover ahead of the meter and by using the blower as a suction device—installing it downstream of the meter. The same outlet fitting normally used with the Cadillac blowers can be installed at the fan inlet. Tests indicate that the capacity of the blowers used as suction devices are substantially the same as when they are used to develop pressure—possibly a few percent less, but not enough to affect their suitability. This arrangement of test elements requires the use of a flow prover having a special (longer) downstream section, with a tap eight diameters downstream from the orifice plate, and also the use of a single column of water gauge arranged for use as a differential pressure gauge. A set of special pressure factors, in place of the pressure factors normally employed, must be used.

Meters

Developing a Plastic Gas Meter. L. A. Dixon, Jr. *A.G.A. Monthly 43,* 15 (1961) Oct. (3 pp.)

Six years ago, Rockwell Manufacturing Company began a research program aimed at development of an adequate, economical plastic gas meter case. Since then thousands of plastic cases have been molded from hundreds of resin formulations and evaluated in myriad tests. Rockwell research for an acceptable plastic has actually been augmented and intensified. The chemical engineering group, and the technical and production staff at the DuBois, Pa., gas meter plant, are confident of eventual success.

How to Determine Internal Condition of Gas Meters: Rec-

ord Differential Pressure. *Gas 37,* 76 (1961) Nov. (2 pp.)

Evaluation and development tests of domestic meters at Southern California Gas Co. require that the internal conditions of a meter be examined while the meter is in operation. A number of faulty conditions that may exist in a meter can be determined by measuring differential pressure with a strain gauge transducer and recording the differential pressure on a Brush Instruments direct writing recorder.

Pressure Regulation

Nonstationary Flow of Compressible Gas in Long Pipelines. L. A. Movsesyan. Inzhener, Fiz. Zh. 4, 1, 22 (1961) Jan. (5 pp. Russian Text). *Appl. Mech. Rev. 14,* 802 (1961) Oct.

An approximate theoretical method is given for calculating the possibility of accumulating gas at the end portion of long pipelines where, due to its practical use, the flow is essentially nonstationary. The problem is reduced to the heat conduction equation, by assuming one-dimensional isothermal gas flow, neglecting inertia forces. The solution is found using the Laplace transformation method.

W. Fiszdon

9. GAS FUEL UTILIZATION AND APPLIANCES

Absorption Cooling

The Mollier *i* - *x* Diagram for Wet Air and Its Technical Application. Dresden, Verlagsbuchshandlung Theodor Steinkopf, 1960 German Text, from *Appl. Mech. Rev. 14,* 807 (1961) Oct.

The present diagram is cast in the more conventional units; kilogram, kilopound, kilocalorie, meter, etc. The introductory part contains a discussion of the *i, t*(enthalpy-temperature), *t, x* (temperature-moisture) content diagram, together with a brief description of instruments and line diagrams of installations used in air-conditioning and allied industries which serve as illustrations for the use of the Mollier diagram. The treatment is straightforward, except that a short section is devoted to the processes of compression and expansion in humid air.

J. Kestin

Air Conditioning

Using Natural Gas Engines as Air Conditioning Prime Movers. J. H. Gill. *Heating, Piping & Air Conditioning 33,* 152 1961) Nov. (5 pp.)

The general subject of selecting and applying natural gas engines as prime movers for air conditioning equipment is explored. The subject is divided into three areas of interest: the kind of a performance a gas engine should be capable of delivering to be acceptable as power for conventional equipment or for heat pumps; what the purchaser can justifiably expect when using natural gas engine power; and what to consider when selecting and applying gas engines.

World's Biggest Bakery Installs Huge Gas Air Conditioning Units. *Ind. Gas 40,* 13 (1961) Oct. (2 pp.)

Three steam operated absorption units will cool half of the main plant and part of a new addition; installation costs total about $750,000, but 3000 ton job will consume $49,000 in gas against an estimated $74,000 for electricity. Absorption units make use of excess boiler capacity in summer months. Steam not needed for processing or heating is utilized, resulting in improved boiler efficiency and lower steam costs. Since absorption machines have no large high-speed moving parts, they are virtually vibrationless and may be installed anywhere. The absorption machine consists of an absorber, generator, condenser, and evaporator. Salt, reactivated by heat provided by the steam, absorbs the refrigerant which is common tap water.

Appliances

Automatic Butane Diluters Aid Appliance Testing. R. Thompson. *Am. Gas. J. 188,* 39 (1961) Oct. (2 pp.)

Installed outdoors in a 2 compartment weatherproof metal cabinet, 2 Selas butane-air mixers—one 1000 CF/hr and one 2000 CF/hr—complete with explosion proof electrical controls and safety auxiliaries, are simplifying this testing. The laboratory utilizes pre-selected fuel mixtures ranging in value from 525 to 1400 Btu/CF delivered at constant pressure, to the appliance testing them.

Preway Develops Gas Dishwasher. *Appliance Manufacturer 9,* 51 (1961) Oct. (3 pp.)

Thermostatically controlled gas heater preheats all water to exact temperatures for the washing and rinsing cycles. This automatically makes higher water temperatures for washing and rinsing possible. The elevated temperatures also eliminated the need for added heat for drying. This new gas appliance now enters the ranks with the marketing of the gas dishwasher and adds another link to gas appliance package kitchen sales.

Combustion

Effect of Fuel Composition on High Frequency Oscillations in Rocket Motors Burning Premixed Hydrocarbon Gases and Air. J. R. Osborn and J. M. Bonnell. *ARS J. 31,* 1397 (1961) Oct. (5 pp.)

The experiments reported were concerned with the determination of some of the factors which contribute to the occurrence of transverse and longitudinal modes of combustion oscillation in rocket motors burning gases. Three rocket motors having different combustion chamber geometries were employed, using gaseous hydrocarbons premixed with air as propellants; the fuels were methane, ethane, superheated propane, ethylene, and hydrogen. The findings indicated that the incidence and amplitude of the combustion pressure oscillations were profoundly influenced by the coupled effects of the chemical composition of the fuels and the aspect ratio of the cylindrical combustion chamber.

Methods of Evaluating the Combustion Behavior of Gases. I. Lorentz. *Gas-u. Wasserfach 102,* 1057 (1961) Sept. 29 (8 pp.)

The important combustion properties of gases included the influence of pressure, gas density, calorific value, and combustion velocity. These properties are expressed as its behavior as a fuel, as for example, the heat production and the combustion value. The question of exchangeability is tightly bound to this behavior. The different processes of judging fuel behavior are based on the Wobbe number as well as the ignition velocity. These all have the disadvantage in that they try to explain the combustion behavior as a function of the fuel and an undefined burner factor. Recent work on burner factors and their influence is reviewed and applied to the problem.

Dryers, Clothes

Whirlpool's Modulating Gas Dryer. *Appliance Manufacturer 9,* 43 (1961) Oct. (3 pp.)

Modulated heat control system on the Mark XII dryer reacts to exhaust temperature to regulate heat input to the dryer. Initially, input is at maximum, then decreases as clothes dry. An exhaust sensor controls gas flow.

Drying

Field Tests of Grain Drying with Flame Show Promise. J. F. Blair. *Butane-Propane News 23,* 56 (1961) Nov.

Drying grain sorghum seed in the field has proved successful on its first field tests, and is being tried on several area farms. Tested for the first time at the High Plains Research Foundation at Halfway, Texas, during the fall of 1960, the technique was taken to the field this past summer. The fields varied in moisture content at the beginning, ranging from 28 to 35%. After flaming, the moisture percentage dropped from 35 to 13.5% in seven days. The untreated fields still had 39% moisture at the end of seven days.

Flame Research

Flame Luminosities of Hydrocarbons and Hydrocarbon Mixtures Burned in the Gas Phase. C. F. Wurster, Jr., J. O. Smith, and C. N. Satterfield. *J. Chem. Eng. Data 6,* 626 (1961) Oct. (5 pp.)

During the combustion of a hydrocarbon fuel in a jet engine, the extent to which microscopic carbonaceous particles form in the flame can substantially affect engine performance was shown. Incandescent carbonaceous particles increase the rate of radiant energy transmission to the walls of the combustion chamber, resulting in increased wall temperatures. Excessive wall temperature shortens combustion chamber life, and incomplete combustion of the fuel represents a loss in fuel efficiency, leading to decreased range and payload. Therefore advantages could accrue from use of a jet fuel with little tendency to form carbon in the flame. Although carbon formation can also be controlled by modifications of engine design such as premixing techniques or varying fuel-air ratio, accompanying space, weight, or other penalties may make it impractical.

Stoichiometry. A Tool in Gas Appliance Development. J. C. Mueller. *Gas 37,* 94 (1961) Oct. (4 pp.)

Stoichiometry is the study of volume, mass, and energy relationships in chemical reactions. In gas appliance engineering, this means the combustion reactions between fuel gas and air. It is here greatly simplified since all reactions are in the gaseous state at pressures and temperatures where the conventional gas laws apply within limits of accuracy sufficient for daily use.

Furnace Operation

Blast Furnace Fuel Oil Injection. W. R. Rombough. *J. Metals 13,* 743 (1961) Oct. (3 pp.)

Tests conducted by Dominion Foundries & Steel Co. in conjunction with Esso Research have shown that heavy fuel oil is a satisfactory fuel for replacing coke in the blast furnace; furthermore, fuel oil injection adds a new tool for the control of furnace operation. Esso Research was interested in demonstrating the coke savings associated with various operating conditions, total fuel cost savings, and production increases to show that injecting heavy fuel oil into blast furnaces is an attractive operation.

Huge Ingot and Slab Heating Facilities Serve Largest Aluminum Hot Rolling Mill at Alloys Plant of Reynolds Metals Company. *Ind. Heating 28,* 1864 (1961) Oct. (6 pp.)

Seven new dual purpose furnaces with a capacity of over 1200 tons of aluminum ingots or slabs, and 14 new soaking pits capable of holding 2300 tons of aluminum at temperatures to 1150°F, are now in operation at the plant in Sheffield, Alabama. Each of these furnaces is heated by 50 gas-fired radiant tubes burning up to 24,000 CF gas/hour/furnace.

Heat Treating

Gas Helps Skefko to Turn the Wheels of the World. E. Ford. *Gas J. 308,* 212 (1961) Oct. 4 (6 pp.)

Not all rolling bearings are the small components with which the average person is familiar. Some of the most vital components of modern machinery and equipment perform their essential duties unseen and are largely taken for granted by those who benefit from their service. Ball and roller bearings, which are incorporated in countless items of machinery, from small domestic equipment to huge steel rolling mills, provide an interesting example. Skefko Ball Bearings Company makes extensive use of gas for heat treatment of its roller bearings, taking some 60MMCF annually for this purpose.

Open Coil Annealing. Pt. II. V. J. Gibbons. *Gas World 85,* 73 (1961) Oct. 21 (2 pp.)

Results of experimental work to date on pilot open coil annealing equipment have indicated that the annealing method can be used to produce drawing-quality sheet steels with very uniform mechanical properties. In the experimental work, properties equivalent to those

or conventionally box annealed, rimmed, and aluminum killed steels were developed with a soaking time of 2 hours. Also, it has been found that all tin-plate tempers can be produced by open-coil annealing of the normal grades of tin-plate steel.

Incinerators

Incinerator Furnace Temperature. H. G. Meissner. *J. Air Pollution and Control Assoc. 11,* 479 (1961) Oct. (4 pp.)

Recommended procedure and factors of primary importance are covered for the design and operation of a refuse incinerator, so that calculation and maintenance of the optimum furnace temperature is possible. For any given furnace and fuel there is a fairly definite and rather easily determined optimum furnace temperature which can be calculated, when certain controlling factors are known or assumed. These factors include fuel characteristics such as ash fusion temperature and moisture content for solid fuels; also unit heat value, as well as the furnace size and design, water cooling or refractory wall construction, including boiler or other heat absorbing or "black" surfaces.

Industrial Heating

Chromatographic Control of Gantry Furnace Atmosphere Proving Advantageous. *Ind. Heating 28,* 1915 (1961) Oct. (3 pp.)

Atmosphere of a 40-ft-high gantry furnace is automatically analyzed and controlled through means of chromatographic instrumentation. Control panel provides for rapid and accurate percentage readings of methane, nitrogen, carbon monoxide, and carbon dioxide; carbon dioxide concentration is controlled to within 0.02% by means of a closed loop control system tied into the pneumatic assembly.

Ovens

Gas Ovens Make Plastic Signs Practical. H. G. Kanode. *Am. Gas. J. 188,* 45 (1961) Oct. (2 pp.)

Simplicity of use is the reason given by the world's largest manufacturer of plastic illuminated signs as to why natural gas is used in the production of signs and displays. Neon Products Inc. of Lima, Ohio, pioneered in the design and development of colorful outdoor and indoor lighted plastic signs.

Refrigeration

Distilling Gas to Get Helium or Ethane. *Can. Chem. Processing 45,* 71 (1961) Oct. (4 pp.)

Low temperature separation of natural gas components may be more practical as Fluor Corporation comes up with unique demethanizing and refrigeration steps, as related to low temperature fractionation or separation of natural gas into at least some of its components. This technique is directed primarily to an improved process for the separation of nitrogen, or both nitrogen and helium, by methods characterized by their greater practicality and economy than those customarily used or previously proposed. Imperial Oil, British-American, and Texaco have reported discovering inert gases containing up to 2% helium in drilling tests in Southwestern Saskatchewan.

Turbines

Progress Review No. 50: Gas Turbines. R. G. Voysey. *J. Inst. Fuel. 34,* 440 (1961) Oct. (8 pp.)

The last decade has seen steady progress in the use of the gas turbine. At the beginning of the decade the outstandingly successful application was for military aviation and this still uses most turbine fuel. Now, civil aviation can make best use of the gas turbine's high power, low weight, and efficient propulsion of high speed airplanes. Progress in the industrial field has been much slower but is accelerating. The industrial gas turbine uses only clean, ash-free fuels, although it can compete with the compression-ignition engine on selected residual fuels. The capital cost of industrial turbines now compares very favorably with large diesels, and with steam turbine sets of all sizes. Future large-scale use of gas turbines depends on the feasibilty of nuclear-powered turbines or cheap turbines for transport applications, but it will require another decade to explore this possibility. A number of other applications are reviewed and reference made to 41 sources of other application.

10. EQUIPMENT AND INSTRUMENTATION

Automation

Automation — For the Operator. F. L. Friedli. *Pipe Line News 23,* 44 (1961) Oct. (2 pp.)

Automatic control systems for engines, engine-compressors, electric motors, turbines, and other types of prime movers have not reached the design point where they will replace all operating personnel. Instead, some systems recently put into operation in process, pipelines, and production fields have permitted operators to obtain additional skills and to increase their, and their companies' productivity. Practically all design concepts evolved today are the result of the operators' creative ideas translated by engineers into hardware.

Design of Heat Exchangers by Digital Computers. D. K. Houtby. *Chem. Proc. Eng. 42,* 442 (1961) Oct. (5 pp.)

It is becoming increasingly important, in order to save time, to apply computing techniques to the design of a chemical plant. A most suitable plant for design considerations is the heat exchanger—a completely self contained unit for which all relevant design criteria are specified by process considerations. A project currently undertaken at the Bradley Institute of Technology is seeking to evolve a universal program by means of which sizes of heat exchangers can be determined using a digital computer. Present indications tend to show that, on a cost basis, computer design can just break even when compared with manual computation.

Instruments

Aspects of Instrumentation and Control. J. G. B. Whitelaw. *Gas World 154,* 310 (1961) Sept. 9 (3 pp.)

In the planning of the 9—12 MMCF/day water gas plant, a central control room, with a comprehensive arrangement of instruments was proposed in order to satisfy two basic objectives. The first was to cater for a minimum of operating labor. This required centralized presentation of all important plant operating characteristics and alarm conditions, and the provision of automatic control systems. The second objective was to provide for the recording of relevant data which could be used subsequently for plant efficiency checks and as a guide to operational adjustments.

How Performance Curves Help You Select Centrifugal Pumps. H. W. Woodhouse. *Heating, Piping & Air Conditioning 33,* 130 (1961) Nov. (6 pp.)

Knowing exactly the meanings of the various performance curves which illustrate the phenomena of centrifugal pump operation will aid the engineer in selecting and using the proper pump for his particular job. This series is aimed at a better understanding of pumps and systems—and a decrease in the number of disappointing installations.

Valves

Hydraulic Valve Actuators Save Half-Million Dollars. G. G. Gallagher, C. L. Griesbaum, and R. D. Foster. *Instruments and Control Systems 34,* 1859 (1961) Oct. (4 pp.)

One-third of the $1.5-million cost for instrumentation for a butadiene plant was saved by using hydraulic actuation of large (3″ to 30″) gate valves. Reactor is controlled by time control of a sequence of operations. Actuator power is up to 25 hp.

Valves. F. L. Evans. *Petrol. Refiner 40,* 121 (1961) Oct. (16 pp.)

Engineers are taking a longer look at valves in the hydrocarbon processing industry today because they represent a sizable amount spent for process equipment both in capital expenditures and maintenance. Valves account for approximately 8% of new plant capital expenditures. Replacement purchases account for about 10% of the maintenance budget. In this industry approximately 75% of the valves are of the gate variety.

11. MATERIALS OF CONSTRUCTION, AND CORROSION

Corrosion

Corrosion Research Trends in the U.S.S.R. W. G. Cass. *Corrosion Tech. 8,* 309 (1961) Oct. (3 pp.)

One of the main objects in Russian economy for some years has been the development of new sources of raw materials and the effective use and conservation of existing supplies. This aim is probably more intensive and important in regard to metals than anything else, and for this reason the fight against corrosion takes a leading place in research. The amount of work, directed to this end has reached enormous proportions, with a corresponding and impressive array of literature, in books, articles, and proceedings.

Microscope Speeds Diagnosis of Refinery Corrosion. H. M. Wilten. *Petrol. Refiner 40,* 151 (1961) Oct. (8 pp.)

In combating corrosion in an oil refinery, it has been found that in addition to ordinary wasting of metals, many different types of corrosion occur. To differentiate these special corrosion problems, the aid of the microscope analysis has been found invaluable. To illustrate how metallographic diagnosis helps clarify and identify failures, a few classified examples are described. It is shown that very often failure is caused by a combination of factors including the types, quality, and condition of the metal or alloy, and to the service environment, rather than to any one specific factor.

Metallurgy

Cathodic Protection for Plant Structures. B. Husock. *Pipe Line News 23,* 55 (1961) Oct. (5 pp.)

Within recent years, cathodic protection has become a standard, accepted practice for the prevention of corrosion of underground pipelines. This is particularly true of the cross-country pipeline, and is shown by the fact that almost every cross-country pipeline of any consequence installed today, is coated and provided with cathodic protection. The corrosion problems which afflict the cross-country pipeline also afflict underground structures at manufacturing plants. For this reason, cathodic protection at manufacturing plants has received considerable attention. The application of cathodic protection at plants is not limited to pipelines, but includes facilities such as buried tanks, lead sheathed cable, steel piping, well casings, among others.

Piping

Flexible Metal Hose, Properly Used, Can Take the Strain Out of Piping Problems. *Heating, Piping & Air Conditioning 33,* 120 (1961) Nov. (5 pp.)

The use of flexible metal tubing (hose) in piping systems to help solve problems of pipeline motion, vibration, misalignment, etc., is well established, but there are some points which the designer and/or installer should remember when considering such devices. These points help the engineer to get the most from the connectors, and the most from the piping system.

Gas Cuts Costs for Structural Steel Fabricator. R. M. Austin. *Gas 37,* 65 (1961) Nov. (3 pp.)

The acetegen 3 piece tip was found by Pacific Car's technicians to solve many cutting problems when natural gas was used. The extra half row of preheat orifices, makes it possible to cut at a rate comparable to acetylene.

Plastics

Giant Gas Line is Production-Line Coated. *Pipeline Eng. 33,* 59 (1961) Oct. (2 pp.)

To increase throughput, a corrosion-resistant epoxy coating lines two-thirds of the new Alberta-California pipeline's southern section, which permits up to 6% increase in pipeline flow efficiency, cleaner gas, and reduced maintenance costs. The epoxy coating was applied on a production line basis to more than 160 miles of 40 ft pipe joints. One of the largest gas transmission lines in the world, the Alberta-California extends from gas fields northwest of Edmonton, Alberta to Antioch, California; most of it is 36 in. in diameter and its initial deliveries to California will average 415 MMCF/day.

Wire Line's Polypropylene Core Wins Spurs in Corrosive Wells. *Drilling 22,* 76 (1961) Oct. (2 pp.)

Wire rope with a core of extruded polypropylene plastic fibers is proving itself in extreme swabbing and drilling line service. Designed for high temperature and highly corrosive environments frequently found in deep, acid-treated wells, the petrochemical resin core is found to have superior supporting qualities for strands of wire lines. The danger of flattening, squash out, core erosion, or washout is eliminated.

Soil Mechanics

Pore Pressure and Suction in Soils. Conference sponsored by British National Society of International Society of Soil Mechanics and Foundation Engineering at Institution of Civil Engineers, Mar. 30-31 (1960) London, Butterworths 1961, 151 pp. $11.25. *Appl. Mech. Rev. 14,* 828 (1961) Oct.

Skempton shows that Terzaghi's expression of effective stress equals total stress minus pore-water pressure is satisfactory for saturated soils but not for very dense materials, which require different adjustments for shear and volume change. For unsaturated soil an additional adjustment is required for the effective area of air and water pressure. Jennings and Aitchison evaluate these adjustments by tests. Change in potential is used by Schofield to express pore pressure in swollen clay.

E. S. Barber.

Welding

Casing Splitter Eases Crossing Jobs. *Oil Gas J. 59,* 128 (1961) Nov. 6 (2 pp.)

When confronted with a new highway or railroad crossing on one of its existing lines, Texas Eastern Transmission Corp. generally cases the line though occasionally it may relocate it. A homemade casing splitter is used by the Texas Eastern maintenance crews to cut casings in half for highway and railroad crossings. It is easier than hand cutting and cuts a straighter line. After the pipe is uncovered and the casing split, insulators or spacers are installed at approximately 10 ft intervals on the pipeline. These serve to center the casing over the line and to control corrosion by preventing contact between the line and the casing. The bottom line of the casing is then swung into position after the top half has been lowered into the ditch and positioned. The two halves are welded together and the sections are joined with a circumferential weld.

Method of Welding Pipe. H. J. Thielsch (assigned to Grinnell Corp.) U.S. 3,002,191 (1961) Sept. 26.

A method of butt welding metal pipes whose ends lie in other than horizontal planes is claimed. Axial roots are formed on the ends, and the root faces align the pipe. Between the root faces an eccentrically shaped fusible ring is inserted. The rings are shaped to give sufficient filling metal to sag when melted into the root space on the upper half of the pipeline, and likewise to sag from the interior into the root space on the lower half of the pipeline, when the entire ring is completely fused.

12. ANALYTICAL METHODS AND TESTS

Analytical Instruments

Compressibility Factor of Fuel Gases at 60°F and 1 Atm. D. McA. Mason and B. E. Eakin. *J. Chem. Eng. Data 6,* 499 (1961) Oct. (6 pp.)

Modern analytical techniques have improved the accuracy of measurement of gas compositions. For many years fuel gases were analyzed by the Orsat or Podbielniak volumetric techniques. Heating values and specific gravities were also determined at atmospheric conditions for pure components and fuel gas mixtures. Because of low accuracy in the analytical methods, with respect to determination of heavier hydrocarbons, differences between calculated and observed heating values were generally ascribed to experimental techniques, and not interpreted on the basis of gas law deviations. Use of the mass spectrometer and gas chromatograph has led to more accurate and complete analysis of gas mixtures. These analyses can be made on a true mole fraction, or ideal gas basis. Also, accurate ideal gas heat of combustion values can be derived from the work of Rossini and others.

Analytical Procedures

Determination of Composition of Solutions of Organic Liquids by Titration with Water. Application to Systems Composed of Aromatic Hydrocarbons and Lower Alcohols. E. R. Caley and A. Habboush. *Anal. Chem. 33,* 1613 (1961) Oct. (4 pp.)

A titrimetric procedure is used for determining organic liquids in an organic binary mixture. Benzene, toluene, xylene, mesitylene, or *p*-cymene are titrated with a water reagent. Iodine is used as an indicator to render sharper end points.

Chromatography

Analysis of Aqueous Solutions by Gas Chromatography. J. T. Kung, J. E. Whitney, and J. C. Cavagnol. *Anal. Chem. 33,* 1505 (1961) Oct. (3 pp.)

Interference in gas chromatographic analysis of certain alcohols and aldehydes due to water is overcome by using a precolumn of calcium carbide. In the precolumn the water is converted to acetylene, thus keeping water from the chromatographic column.

Applications of Linear Elution Adsorption Chromatography to the Separation and Analysis of Petroleum. I. Compound Class Separations Over Alumina and Silica. L. R. Snyder. *Anal. Chem. 33,* 1527 (1961) Oct. (8 pp.)

Petroleum samples and other natural mixtures are separated into their components by linear elution adsorption chromatography. Separation into compound groups is accomplished using alumina or silica as the stationary medium. Relative elution order and potential compound separability are two aspects considered.

Applications of Linear Elution Adsorption Chromatography to the Separation and Analysis of Petroleum. II. Compound Class Separations by a Routine Micro Procedure. Determination of Gasoline Polyaromatics. L. R. Snyder. *Anal. Chem. 33,* 1535 (1961) Oct. (4 pp.)

A quick, convenient, and reproducible technique is devised for separation and determination of petroleum compounds and compound classes. Total naphthalenes and phenanthrenes are separated by micro linear adsorption chromatography and determined spectrophotometrically.

Application of Linear Elution Adsorption Chromatography to the Separation and Analysis of Petroleum. III. Routine Determination of Certain Sulfur Types. L. R. Snyder. *Anal. Chem. 33,* 1538 (1961) Oct. (6 pp.)

Sulfur compounds in heavy petroleum samples are separated by linear elution adsorption chromatography. The technique affords the separation of alkyl thiophenes, alkyl monosulfides, and nonvicinal aromatic sulfides. By comparison of results, the Hastings method indicates high results for certain sample types.

Automatic Analysis of Ditch Gases by Vapor-Phase Chromatography. D. J. Fraade. *Erdol u. Kohle 14,* 720 (1961) Sept. (6 pp.)

For the detection and analysis of ditch gases, automatic gas chromatography offers a method that is simple to put in operation, that yields results easily interpreted, and that requires practically no attention. Chart data are simple to read yet comprehensive in nature. The instrumentation can be highly flexible and the cost is not excessive. The process involves quantitative measurement in a thermal conductivity cell of gaseous components separated by adsorption and partitioning as the ditch gas is carried through the chromatographic column. Some interesting results of the practical application of the instrument are reported.

Continuous Analysis of Helium in Natural Gas by Chromatography. C. L. Klingman and J. D. Marshall. *U.S. Bur. Mines Rep. Invest. 5873.* (Washington, D.C.: U.S. Govt. Print. Off., 1961)

In extracting helium from natural gas at Bureau of Mines helium plants, a continuous analysis of the helium content of inlet and outlet gas streams is required to determine the extraction efficiency. An analyzer, using established principles of gas chromatography to effect the analysis, has been developed by the Bureau of Mines to meet this need. It will record the helium content of inlet or discharge gases from helium-extraction plants every 5 minutes, continuously, without the attendance of an operator. A 25 in. column of activated charcoal is used as a partitioning agent; nitrogen is the carrier gas; and a hot-wire, thermal-conductivity cell is the detector. A 1.0 mv strip chart indicates the unbalance of the detector cell. Sample size is 0.37 cc and carrier gas flow rate is 75 cc/min.

Cryogenics

Measurement of Thermal Expansion at Low Temperatures. G. K. White. *Cryogenics 1,* 151 (1961) Mar. (9 pp.)

Recent developments in the accurate comparison of small capacitances have made it possible to detect very small length changes. Three terminal capacitors are compared in a bridge with transformer ratio arms, the bridge sensitivity of 10^{-6} pF allowing length changes of less than 10^{-8} cm to be detected. This makes possible the determination of the linear thermal expansion of solids at temperatures down to $\Theta_D/50$ and less. A description is given of the bridge, reference capacitor, 'expansion' capacitor, associated cryogenic problems, and some results obtained.

Instruments & Tests

Design and Calibration of an Inexpensive Free-Flow Electroviscometer. P. A. D. de Maine and E. R. Russell. *Can. J. Chem. 39,* 1929 (1961) Oct. (5 pp.)

An automatic viscometer designed to measure flow times accurately without constant attention by the operator has been reported. This viscometer used a photoelectrically triggered timing device to measure flow times to within 1 part in 10,000. An electric resistance stream gauge type viscometer has also been designed. A new modification of the Ostwald-Fenske viscometer is described which can be immersed in the usual thermostated bath. Even the low flow times, less than 30 seconds, are measured electronically to better than 1 part per thousand.

Differential Thermometric Titrations and Determination of Heats of Reaction. B. C. Tyson, W. H. McCurdy, Jr., and C. E. Bricker. *Anal. Chem. 33,* 1640 (1961) Nov. (5 pp.)

An apparatus utilizing thermistors for conduction of thermometric titrations which measures the difference in temperature between the reaction vessel and a blank solution is described. To eliminate a high impedance recorder and simultaneously to realize the sensitivity of high resistance thermistors, four 100,000 ohm thermistors are connected in parallel for each of the detectors in the differential circuit. The response of the electrical circuit is analyzed mathematically in order to achieve a linear response of the circuit to differences in temperature between the two sensing elements. Because of its linear response, electrical power can be used as a standard for calibrating the apparatus, so that heats of reactions can be measured rapidly and simply.

Measurement of Trace Quantities of Hydrogen Sulphide in Industrial Atmospheres. A. F. Smith, D. G. Jenkins, and D. E. Cunningworth. *J. Appl. Chem. 11,* 317 (1961) Sept. (13 pp.)

Although methods have been published for the measurement of traces of H_2S in air, no mention is made of their reaction to SO_2, which is invariably present in the atmosphere, particularly in industrial areas, in concentrations vastly in excess of that of the H_2S. In some cases, the calibration and ultimate limits of detection are also in doubt. This work includes a critical practical appraisal of 5 alternate methods with respect to interference of SO_2, maximum flow rate, and limit of detection, and their accurate calibration to low levels by both volumetric and gas dilution techniques. Modifications to eliminate interference by SO_2 are also described. A description is given of a simple portable field apparatus capable of measuring concentrations of H_2S down to 10^{-4} ppm in a 2 hr sampling period, together with typical field levels found when using it.

Mass Flowmeter

Proving-Out the Mass Flowmeter. K. Kridner. *Gas 37,* 120 (1961) Nov. (4 pp.)

The problem resolved into determining unit mass passing through the instrument during a unit time whereby a direct comparison could be made for calibration. A procedure was selected that was uniquely simple. The amount of air passed during a unit time was weighed on a commercial scale and at the same time exhausted air through the mass-flowmeter was measured; by comparing weight loss in the closed system as shown by the scale with the unit mass (weight) passed on the meter, a direct correlation results.

Thermistors

Method of Linearizing Thermistor Thermometer Data in Calorimetry. H. V. Larson, I. T. Myers, and W. H. LeBlanc. *J. Sci. Instruments 38,* 400 (1961) Oct. (2 pp.)

A method for correcting the non-linearity of thermistor thermometers in calorimetry is described. The correction may either be experimentally determined, or calculated from the thermistor specifications. This system of reducing thermistor data was applied to measurements over temperature differences of several degrees in two different adiabatic calorimeters. A linear temperature resolution of 10^5 to 1 was easily obtainable.

The Accuracy of Measurement of Temperature with Thermistors. A. G. Shashkov. Inzhener, Fiz. Zh. 3 No. 3, 123 (1960) Mar. (3 pp.) *Appl. Mech. Rev. 14,* 815 (1961) Oct.

Attention is brought to the fact that precision of temperature measurements by means of thermistors depends on the accuracy of assessment of heat-transfer coefficient. A change of state of a medium results in a change in the heat-transfer coefficient and leads to an error in the temperature measurement.

S. Smoleniec

Transducers

Variable-Reluctance Pressure Transducers. S. Epstein. *Instruments and Control Systems 34,* 1876 (1961) Oct. (2 pp.)

Variable-reluctance pressure transducers, particularly the diaphragm type possess a number of important features: ability to withstand severe shock and vibration environment; extreme overload tolerance (operator proof); Dynamic response for liquid as well as gas systems due to high natural-frequency, low internal-volume, and low volumetric displacement; ability to accept corrosive media for pressure differential as well as gage-pressure measurements, and high signal output level.

13. BASIC SCIENCE

Absorption

An Analysis of Spray Evaporation in a High-Temperature Environment. T. W. Hoffman and W. H. Gauvin. *Can. J. Chem. Eng. 39,* 179 (1961) Oct. (10 pp.)

The present paper discusses the difficulties inherent in the calculation of the absorption of thermal radiation by clouds of particles suspended in an absorbing gas medium. Approximations to the intractable exact solution are made to permit the calculation of the absorption strength of spray from operating conditions and the properties of the atomized liquid. The method is an extension of the Hottel-Cohen analysis of the radiant heat transfer to an absorbing gas of non-uniform temperature and permits the calculation of the magnitude and distribution of the heat flux at the wall.

Combustion

Controlled Combustion Reactions of Light Hydrocarbons. J. H. Jones, H. D. Allendorf, D. G. Hutton, and M. R. Fenske. *J. Chem. Eng. Data 6,* 620 (1962) Oct. (4 pp.)

Highly exothermic vapor phase oxidation reactions are easily controlled by conducting them in the presence of a "rain" of solids which removes reaction heat and prevents combustion. With the proper choice of conditions and solids flow rates, temperatures of hydrocarbon-oxygen reaction mixtures can be maintained within a 5° to 10° C range. The amount of solids needed for good temperature control occupies only a small proportion (less than 1% by volume) of the reaction to occur in what is essentially an open tube. Previous work demonstrated the usefulness of a rain of solids in oxidizing hexane and higher hydrocarbons; this article describes results obtained with a number of butanes, butenes, and propane.

Gas Burner Produces 6000°F Temperatures by Adding AC Electric Energy to Combustion Gases. *Ind. Heating 28,* 1928 (1961) Oct. (3 pp.)

In this new burner, alternating current electrical energy is added to boost the temperature of the already hot gases of combustion rather than to heat gases from ambient levels, as is the case with standard DC plasma jets. The temperatures which appear to be obtainable in this burner lie in the range between 3,000 and 6,000°F for fuel and air mixtures. The use of AC power rather than DC, eliminates the need for rectifiers or converters and permits operation of the burner at conveniently high voltages.

Computers

Next Step Beyond Transistor. *Bus. Week No. 1678,* 45 (1961) Oct. 28 (2 pp.)

Molectronics is shrinking electronics so a component makes up a whole circuit. A general-purpose computer only slightly larger than a sardine can was displayed by the Air Force and Texas Instruments, Inc. as an example of the almost magical new art of molecular electronics. In this tiny computer, 587 parts are crammed into a scant 6.3 cu in. This is quite a packaging feat, but more important each of these 587 parts is a complete electrical circuit on a sliver of metallic silicon smaller than a slice from a grain of rice. To duplicate this circuitry with conventional modern techniques requires 8,500 components on 67 printed circuits to provide interconnections. This would weigh 30 lb compared with the new computer's 10 oz.

Diffusion

Diffusion Coefficients in Hydrocarbon Systems. H. H. Reamer and B. H. Sage. *J. Chem. Eng. Data 6,* 481 (1961) Oct. (4 pp.)

Earlier investigations of the molecular transport of the lighter paraffins in the liquid phase of hydrocarbon mixtures initiated by Lacey have been supplemented by more recent studies extending to higher pressures and temperatures. The experimental information available to date indicates a wide variation in the Fick diffusion coefficient with state. The possible resistance to diffusion at the gas-liquid interface is not important at the pressures involved. The present study is concerned with the molecular transport of ethane in the liquid phase of the ethane-*n*-pentane system at pressures up to 700 psia at temperatures between 40° and 280°F.

Investigation of Molecular and Thermal Diffusion by the Similarity Method. A. G. Usmanov and A. I. Berezhnoi. Konvektivnyi i Luchistyi teploobmen Moscow, Izdate'lstvo Akad. Nauk SSSR, 1960 (7 pp. Russian text) *Appl. Mech. Rev. 14,* 806 (1961) Oct.

In order to extend the range of available data on molecular and thermal diffusion of gases a generalized equation is derived relating the mass flux ratio under isothermal conditions with corresponding entropy change. Application to evaluation of diffusion coefficients for vapors in gases results in an agreement with available experimental data within 1% at an average.

S. Smoleniec

Equilibria

Mean and Equilibrium Structures of Methane and Deuteromethane as Determined by Electron Diffraction. L. S. Bartel, K. Kuchitsu, and R. J. deNeui. *J. Chem. Phys. 35,* 1211 (1961) Oct. (8 pp.)

The structural parameters of methane and methane-d_4 were determined with the new rotating sector electron diffraction apparatus of Iowa State University. The results showed for the first time by electron diffraction, the existence of isotope effects on structure. The isotope effects were just those expected for atoms of different mass vibrating in identical anharmonic force fields. Vibrational anharmonicity led to measurable phase shifts in the molecular diffraction patterns from which the asymmetry of the internuclear distribution functions could be determined. This allowed a direct experimental determination of the approximate equilibrium C—H and C—D bond lengths, giving 1.08_2A. Somewhat more rigorous calculations of the correction from the mean to equilibrium distances based on anharmonic Urey-Bradley field led to equilibrium C—H and C—D bond lengths of 1.084_7A and 1.086_3A respectively. Corresponding equilibrium bond lengths computed from the spectroscopic r_0 values of 1.094_0 and 1.092_3A respectively, were 1.085_0 and 1.085_6A.

Vapor-Liquid Equilibrium at Atmospheric Pressure. Systems Containing Ethyl-Alcohol, *n*-Hexane, Benzene, and Methylcyclopentane. R. C. Belknap and J. H. Weber. *J. Chem. Eng. Data 6,* 485 (1961) Oct. (4 pp.)

Vapor-liquid equilibrium relationships at atmospheric pressure for the ternary system *n*-hexane-benzene-methylcyclopentane and the quaternary system ethyl alcohol-*n*-hexane-benzene-methylcyclopentane were determined. The latter system was investigated at *n*-hexane concentrations of approximately 35 and 50 mole % in the liquid phase. Two of the possible four ternary systems which can be made with the four compounds have been investigated and additional quaternary data are available. The experimental results show that the ternary system deviated from ideal liquid phase behavior as did the quaternary system. No ternary azeotrope was formed.

Flame Research

Flame Ionization Hydrocarbon Analyzer. R. A. Morris and R. L. Chapman. *J. Air Pollution Control Assoc. 11,* 467 (1961) Oct. (4 pp.)

The empirical basis for the flame ionization method is the observation that while the flame of pure hydrogen contains an almost negligible number of ions, the addition of even traces of organic compounds produces a large amount of ionization. In practice, the sample to be analyzed is mixed with hydrogen fuel and passed through a small jet.

Flame Propagation in Two and Three Component Gaseous Mixtures Containing Hydrogen, Methane, Nitrogen, and Nitrous Oxide. L. S. Kozachenko and G. I. Skachkov. P.M.T.F., Zh. Prikl. Mekh. Tekh. Fiz. 1 No. 2, 93 (1960) 7 pp. *Appl. Mech. Rev 14,* 816 (1961) Oct.

Results are discussed of measurements of normal burning velocities U_n measured at normal temperature and pressure. Most U_n values were obtained by burner method and some by constant pressure bomb with Schlieren photograph method. U_n values in mixtures with N_2O, lower than in corresponding N_2-O_2 mixtures, are probably conditioned by secondary reactions of N_2O in the burning zone. An empirical formula for U_n values is given as a function of the N_2 amount in the H_2-N_2O-N_2 mixtures.

N. Manson

Fluid Flow

Some Techniques for Investigating the Unsteady State Molecular Flow of Gas Through a Microporous Medium. E. T. Nelson and P. L. Walker, Jr. *J. Appl. Chem. 11,* 358 (1961) Sept. (7 pp.)

An experimental method has been developed which is capable of measuring the unsteady-state molecular flow of small volumes of gas from a microporous solid such as are encountered under thermal conditions unfavorable to adsorption. Two new computational procedures, which do not use the severe simplifying assumptions of existing methods, are described for evaluating diffusivities from unsteady-state diffusion data. They are applied to some experimental results on the diffusion rates of several gases from synthetic zeolites.

Freezing Techniques

Saline Water Conversion by Freezing. H. F. Wiegandt. U.S. Office of Saline Water. *Saline Water Res. Dev. Prog. Rept. No. 41.* (Washington, D.C. Aug. 1960. P B 161906)

Large sea water conversion plants which in their operating cycle produce ice with the use of direct-contact, immiscible refrigerant should ultimately be able to produce potable water with a work-energy requirement of less than 6 Btu/lb product. The present design for a 10 million gallon/day plant shows a requirement of 11.8 Btu/lb of product with an estimated product cost of $0.38/Mgal. The plant cost is equivalent to $0.67/daily gallon.

Heat Pump

"World's Largest" Heat Pump Revisited. *Heating, Piping & Air Conditioning 33,* 115 (1961) Nov.

An ingenious well water heat pump system using natural gas driven compressors, supplementary air handling units, and individual store air conditioner has been operating in the Southdale shopping center, Minneapolis for about five years. How it has worked, what changes have been made, and what its economy rating is. These and other questions are answered, and interesting operating data for summer and winter peak load periods are given.

Heat Transfer

Generalized Transfer Factors for Granular Beds. G. C. Yeh. *J. Chem. Eng. Data 6,* 526 (1961) Oct. (5 pp.)

Several of the heat and mass transfer and the pressure drop characteristics of packed and fluidized beds, the subject of many studies are compared, and a generalized correlation of the data are suggested. Areas in which further work is desirable are also mentioned.

Approximate Solution of Non-steady Problems in Heat Conduction. V. I. Bukharin and V. I. Danilovska. Inzhener. Sbornik Akad. Nauk SSSR 30, 112 (1960). *Appl. Mech. Rev. 14,* 808 (1961) Oct.

Paper considers the problem of an infinite hollow cylinder of radii a and b which is at constant temperature T_o at time $t = O$ and which exchanges heat with systems of temperature $T_1(t)$ and $T_2(t)$ at $r = a$ and $r = b$, respectively, with the proviso that the coefficients of heat transfer h_1 and h_2 are also time dependent. An approximate solution in the form of the quadratic polynomial $T = b_1(t) + b_2(t)r + b_3(t)r^2$ is obtained.

J. Kestin

Heat and Mass Transfer During Evaporation of Liquid in a Forced Gas Flow. G. T. Sergeyev. Inzhener. Fiz. Zh. 4 No. 2, 77 (1961) Feb. (5 pp.) *Appl. Mech. Rev. 14,* 814 (1961) Oct.

Experimental data are presented on heat and mass transfer by evaporation from water, acetone, benzol, and butyl alcohol to air in turbulent flow. The air Reynolds number was varied from 20 x 10^3 to 150 x 10^3, temperature from 20 to 200°C, and moisture from 15 to 80%. The correlation proposed by Nesterenko is in good agreement with his experimental data.

N. Zuber

Heat Exchange in the Initial Portion of a Straight Tube with Different Inlet Forms. V. V. Gutarev. Trudi Mosk. In-ta Khim Machinostr. 15, 25 (1958) 16 pp.; Ref. Zh. Mekh. No. 11, 1959. Rev. 13711. *Appl. Mech. Rev. 14,* 810 (1961) Oct.

The character of heat emission in the first portion of a round tube in relation to the inlet conditions is experimentally investigated. The tube is made of copper, with a length of 1806 mm. and a diameter 20/30 mm. The investigations were made with water; Reynolds numbers varied within the limits of 10,000—60,000. For the purpose of altering the inlet conditions 5 removable caps were prepared, classified as regards construction as: a smooth inlet (initial diameter 50 mm), a smooth bend (90°; $R = 3d$), and others. Temperatures were recorded of the liquid, the tube's surface and the emitted heat.

G. Z. Gershuni

Hydrogen Sulfide

Interaction of Hydrogen Sulphide with Nickel, Tungsten, and Silver Films. J. M. Saleh, C. Kemball, and M. W. Roberts. *Trans. Faraday Soc. 57,* 1771 (1961) Oct. (10 pp.)

The interaction of hydrogen sulfide with films of nickel and tungsten over the temperature range of −80° to 100°C has been studied. Rapid dissociative adsorption, followed by desorption of hydrogen occurred on both metals. The average composition of the surface phase was expressed as H_nS and n decreased with increase of both surface coverage and temperature. Adsorption of hydrogen sulfide on silver films at −80° caused sintering to occur; a substantial fraction of the adsorption was reversible, but some dissociation also took place. The completion of the surface layer on nickel at 0°C was followed by the formation of bulk sulfide.

Mass Spectrograph

Mass Spectrographic Analysis of Solids. N. B. Hannay. *Science 134,* 1220 (1961) Oct. 20 (6 pp.)

One of the most promising new analytical methods is mass spectroscopy. Due to the diverse nature of the

problems of interest in the analysis of solids, several mass spectroscopic methods have been developed by workers in this field. High sensitivity techniques have been used to detect specific impurities in certain cases. An "isotope dilution" method with thermal ionization or electron bombardment source, has been applied to certain types of solids analysis and has provided very high sensitivity. The mass spectrograph is not considered as a replacement for the emission spectrograph because it is highly complicated. But it is an extremely useful instrument that can handle semiquantitative problems impossible for the emission spectrograph. Such problems include determination of both bulk and surface impurities which cannot be solved any other way.

Mass Transfer

Estimate Transport Coefficients. L. D. Smoot. *Chem. Eng. 68,* 187 (1961) Oct. 16 (4 pp.)

When solving problems in mass, heat, and momentum transport, it is usually necessary to know the values of the transport coefficients for viscosity, thermal conductivity, and diffusivity. Occasionally, experimental values for these coefficients are available. This review shows the best methods for estimating the transport coefficients for simple gases and liquids at moderate pressures. An extensive survey of techniques was made for estimating the thermal conductivity, viscosity, and diffusivity for gases and liquids in a variety of conditions. The methods include those for mixtures, high pressure, and temperature, and other special cases.

Mass Transfer. C. R. Wilke, J. M. Prausnitz, A. Acrivos, E. E. Petersen, and D. R. Olander. *Ind. Eng. Chem. 53,* 925 (1961) Nov. (9 pp.)

Theoretical interpretation of spontaneous interfacial turbulence highlights progress, and advances continue in liquid diffusion theory combined molecular and turbulent diffusion, and axial mixing effects in flow systems. Molecular diffusion in gases has received little attention during the past year. The few studies which have appeared were devoted primarily to utilizing diffusivity data as measures of the interactions between unlike molecules rather than presenting new data or experimental techniques. The bibliography contains 125 references on numerous phases of mass transfer.

Photochemical Reactions

Mechanism of the Mercury Photosensitized Decomposition of *n*-Butane. R. J. Cvetanovic, W. E. Falconer, and K. R. Jennings. *J. Chem. Phys. 35,* 1225 (1961) Nov. (9 pp.)

The results of further studies of the mercury photosensitized reactions at room temperature of *n*-butane and of its mixtures with nitrous oxide are reported. The importance of a self-scavenging process responsible for low quantum yields of hydrogen at finite conversions has been demonstrated by carrying out experiments at low conversions closely approximating initial conditions. The initial quantum yield of hydrogen has been determined relative to that of nitrogen from the mercury photosensitized decomposition of nitrous oxide. The mechanism of the self scavenging process is discussed.

Rate Constants

The Reaction Between Methyl Radicals and Isobutane. A. R. Blake, J. F. Henderson, and K. O. Kutschke. *Can. J. Chem. 39,* 1920 (1961) Oct. (9 pp.)

It has been confirmed that the apparent rate constant for the reaction between methyl radicals, produced by the photolysis of deuterated acetone, and isobutane increases with decreasing isobutane pressure. An explanation is proposed to account for this observation suggesting that the production of methane by disproportionation betwen methyl and *t*-butyl radicals was not negligible as has been assumed previously.

Thermodynamics

Some of the Thermodynamical and Mechanical Properties of A Liquid. B. B. Kudryavtsev. Ul'traakust. k Issled. Veshchestva, Priminenie. No. 6. Moscow. 1958, 53. Ref. Zh. Mekh. No. 11, (1959) Rev. 13163. *Appl. Mech. Rev. 14,* 808 (1961) Oct.

A semi-empirical relation is advanced for the relation of the velocity of the propagation of sound in a liquid to the potential energy of the interaction of the molecules, the temperature, and some of the physical parameters of the liquid. For the purpose of calculating the potential energy of the molecular interaction of the liquid, a semi-empirical relation of this energy to the volume is employed.

A. I. Golubev

Viscosity

Viscosity of Polar Gases. K. M. Joshi and S. C. Saxena. *Physica 27,* 3, 329 (1961) Mar. (8 pp.) from *Appl. Mech. Rev. 14,* 807 (1961) Oct.

Viscosity data for several polar gases have been interpreted in terms of a modified Stockmayer potential. Potential parameters have been evaluated by a graphical method. Computed values of viscosity have been compared with the experimental data as function of temperature. This procedure has thrown some light on the nature of intermolecular forces and has led to the conclusion that the modified potential can be relied upon only for moderately polar gases. For highly polar gases, this potential may at best serve the purpose of an empirical correlating function for the experimental data.

From authors' summary.

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